

MAINTENANCE MANUAL

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T4005 / 4201

DRAWER UNIT

WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year.

Any questions with respect to the warranty, mentioned above should be taken up with your Tektronix Field Engineer or Representative.

All requests for repairs and replacement parts should be directed to the Tektronix Field Office or representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type (or Part Number) and Serial or Model Number with all requests for parts or service.

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CHANGE INFORMATION

Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry.

SECTION 1

SPECIFICATION

GENERAL DESCRIPTION

The Tektronix T4005 Graphic Display is an integrated, self-contained system designed for the rapid display of large drawings, graphics or text on the slightly modified Type 611 Storage Display Unit contained within it. Selectable scaling allows the graphic information to be shown in its totality, or to be magnified over a range up to 32:1. Thus, any portion of the display may be inspected with an extremely high resolution. With the aid of appropriate parallel interfaces, the T4005 is able to call for, control, and accept graphic information from the present-day digital computers routinely used for generating drawings and graphics.

The T4005's major functional components are: A graphic controller panel, a display unit, a display driver, graphic control, software control circuitry. Interfaces for specific computers, provisions for three additional display drivers, and provisions for auxiliary functions add to the versatility of the T4005.

COMPONENT DESCRIPTIONS

Graphic Controller Panel

An inclined, flat-front panel equipped with back-lighted, push-on push-off, or mutually exclusive pushbuttons, is the primary means of mode selection and control of the T4005 Graphic Display. (The secondary means of control is through the use of computer software.) Some pushbutton functions are: Scale and position of the display, display device(s) selected, T4005 display mode, software control, and control of the computer. Lighted buttons indicate T4005 function status. In addition, there is an indicator window which gives the status of four computer/T4005 functions. The operation of the panel is entirely DC. Thus, it may be removed from its housing and remotely located to serve the user's convenience (optional accessory cables are available for this purpose).

Display Unit

The display unit is a Tektronix Type 611 Storage Display Unit, very slightly modified (only appearance and primary power). Its direct-view, bistable storage tube presents a large screen display of high-density complex graphics and/or alphanumerics without flicker or drift. Alphanumerics are produced by software character generators which give the ultimate in flexibility for character style and size. Using a 4 by 6 matrix and two-dot character separation allows

over 20,000 (very small) characters to be stored within the 1024 by 1024 D/A levels present on the 611 display.

Display Driver

The T4005 Graphic Display has a D/A converter and an output architecture capable of driving four display devices. The standard T4005 is supplied with one Display Controller—611 card installed in Display Device card position 1. Other displays, such as additional 611's, 601's, scan converters, oscilloscopes, and XY plotters can be driven with the addition of extra cost display controllers.

Graphic Control

The Graphic Control electronics of the T4005 are located in the slide-out drawer unit (named the 4201 Graphics Display Controller), which is housed directly under the T4005 Display Unit.

Most of the digital processing of the computer graphic information (such as scaling, offset, Z-axis, etc.) is done in the Graphic Control area. This area contains eight dual-connector cards which perform the following functions:

Card GC-1: Mode Control and D/A Converter. Selection among the READY, FRAME and LOCATOR modes, D/A conversion for the X-axis, AUTO ERASE logic, increment FRAME/LOCATOR Oscillator, AUGMENT control logic.

Card GC-2: Scale and Sector. Gating of the X position register into X-axis D/A converter, most significant bit (MSB) detection for sector control of the Z-axis, least significant bit detection (LSB) for Z-axis control when achieving a new D/A converter level, direction indicator logic, cursor limiting, HOME detection.

Card GC-3: Position Register. The position register for accumulating X-axis input commands, X-axis augmenting circuitry, X-axis last scale latches.

Card GC-4: Offset Register and Loader. Both X and Y axis offset registers and the gating necessary to load their contents into the position registers, jam-transfer circuitry for loading the position registers.

Card GC-5: Position Register. The position register for accumulating Y-axis input commands, Y-axis augmenting circuitry, Y-axis last scale latches.

Card GC-6: Scale and Sector. Gating of the Y position register into the Y-axis D/A converter, most significant bit (MSB) detection for sector control of the Z axis, least significant bit detection (LSB) for Z-axis control when achieving a new D/A converter level, direction indicator logic, cursor limiting, HOME detection.

Card GC-7: Z-axis Control and D/A Converter. Integration of write commands, augment feature, and LSB detection for Z-axis control, D/A conversion for the Y axis, HOME oscillator incrementing, the real time clock discussed under Software Circuitry.

Card GC-8: Frame/Locator Generator. The digital and analog circuitry necessary for the generation of a write-thru frame or locator.

Accessory Area

The Accessory Area of the T4005 is in the slide-out Drawer Unit. It contains room for 12 circuit boards. The circuit boards are connected through one 56 pin connector per board into an interconnect board in the bottom of the 4201 Accessory Area. These Cards perform the following functions:

Acc-1: Spare.

Acc-2: Spare.

Acc-3: Spare.

Acc-4: Software Control Board. Software button encoder's, Button interrupt circuitry, interrupt button A—H light latch and driver.

Acc-5, 6, 7, 8: Display Controller Cards. Each device card contains a horizontal and vertical amplifier, Z-axis delay and write circuitry tailored for the particular device.

Acc-9, 10: GDC Status Word. Gating circuitry necessary to assemble GDC status bits into word lengths of 8, 12, 16, or 24 bits per word.

Acc-11: GDC Status Gate A. Gating circuitry necessary to assemble GDC status bits into word lengths of 8, 12, 16, or 24 bits per word. Level shifting for certain bits.

Acc-12: GDC Status Word Selector. Selects status word and word length of status information returned to the computer. Provides strappable option for Clock and Button Interrupt Identification Bit.

Software Circuitry

The software circuitry consists of an interrupt structure, status information and a real time clock.

The interrupt structure is a latch on Card Acc-4 which is set when buttons A—H on the Graphic Controller Panel are pushed. Computer software then must query the T4005 to find out which button was pushed, and must reset the interrupt latch so that another button interrupt may take place. In addition to buttons A—H, the computer can also sense the state of DISPLAY NUMBER buttons 1—8 (only one of which is selected and lit at any one time). Thus, 64 distinct interrupt states can be sent to the computer by the use of DISPLAY NUMBER buttons and then an interrupt button. Interrupt buttons are not automatically lit upon pushing a button. All of the Interrupt button lights are under software control so that none, one, more than one, or all of the Interrupt lights may be lit. The interrupt feature may be disconnected from the computer by use of an Interrupt Control switch that is provided as part of a specific computer interface. This switch is located at the rear of the T4005 on the cable mounting plate of the interface. It has Enable and Disable positions, as well as a Computer Enabled position which allows the software to enable or disable the interrupt structure.

Ninety-six bits of status information are gated to the computer by GDC Status Gates A, B and C (Cards Acc-9, 10, 11). Depending upon the computer interface installed, these information bits may be transferred to the computer as 8, 12, 16, or 24 bit words, as determined by Interface card Acc-12.

A real-time clock is located on Card GC-7, and is turned on and off by computer control commands. Normally the clock interrupts the computer at a 60 Hertz rate (every 16.7 milliseconds), but provisions are made to allow the external application of other frequencies. The clock may be disabled from interrupting the computer by placing the Interrupt Control switch (located on the rear panel as part of a specific computer interface) to the Disable position. The clock may be turned off by (a) momentarily going to the Interrupt Disabled position, (b) powering the T4005 down and then on again, or (c) making use of a computer reset function if it exists, and if it is provided to the T4005 interface unit.

PROVISIONS FOR OPTIONAL ACCESSORIES

Interfaces

Space and card guides are provided inside the T4005's electronics housing (4201) for interface electronics to a computer or communications equipment. The interface area itself provides for six cards, an interconnect card, and a mounting plate to mechanically hold the computer cable in

place. This mounting plate will normally carry the Interrupt Control switch previously discussed. In addition, provision is made in the Accessory Area for Card Acc-12, GDC Status Word Selector, which must be provided with a specific computer interface in order to determine the word length of the status information returned to the computer.

Display Drivers

In addition to the display driver for the modified 611 installed in the T4005, there are provisions for three additional display controllers, (II, III, and IV) in the Accessory Area (Acc-6, -7, -8) which can drive additional 611's, or 601's, or scan converters, etc.

Auxiliary Functions

Three cards in the Accessory Area (Acc-1, -2, -3) are not dedicated to any specific function. Power and a variety of signal and control functions are terminated on these card connectors. There are provisions for two additional connectors on the rear panel of the T4005. These provide the T4005 with a capability for future expansion with optional accessories, and a versatility to satisfy unusual or special design requirements.

OPERATING DESCRIPTIONS OF CONTROLS, INDICATORS AND CONNECTORS

Front Panel

Primary Power Switch. Provides AC power to the T4005's electronic package and the display device(s) contained in the system. The display devices retain their own standard power switches as well. Powering up the T4005 causes it to go to the following pre-set conditions:

1. DISPLAY SCALE(s) set to the scale predetermined by the user with the options on cards GC-2 and GC-6.
2. READY mode selected.
3. All attached and powered up DISPLAY DEVICE(S) selected.
4. AUTO ERASE off.
5. Software interrupt lights cleared.
6. All register and latches cleared.
7. VERT and HORIZ AUGMENT on.
8. Most SOFTWARE CONTROL functions off.
9. Computer Enabled Interrupt Latch disabled.
10. Real-Time Clock off..

DISPLAY SCALE Field. Indicates which scale is currently selected for that axis. Assignment of the upper row and lower row buttons to an axis is made indirectly by the VERT and HORIZ buttons in the adjacent AUGMENT field. Six scales are available in each axis: 8K, 4K, 2K, 1K, 512, and 256. The button lighted indicates how many step commands along one axis the GDC must receive to drive that axis' D/A converter over its full range of 1024 distinct analog levels. The precise numbers of steps required are 8192, 4096, 2048, 1024, 512, or 256. In the event there are more steps than levels, then the excess steps are uniformly absorbed (cast out) without change in the D/A converter output; e.g., in the 4K selection, every fourth step results in a one level change in the D/A output, while the other three steps are cast out (ignored). In the event there are fewer steps than D/A levels, two options are available. 1) The data can be displayed as received; e.g., two D/A level shifts per input step in the 512 selection and four in the 256 selection. This option separates the displayed dots, weakening the intensity of the display. 2) The AUGMENT function can be selected to compensate for the intensity loss.

The display scales can be selected by pushing the buttons or by computer command.

AUGMENT Field. Indicates by a lighted VERT or HORIZ (or both) button(s) when the T4005 is augmenting the 512 and/or 256 DISPLAY SCALES. The AUGMENT mode inserts additional dots between those indicated by the step commands received. In the case of a 512 AUGMENT on one axis and a 256 AUGMENT on the other, the one additional dot for the 512 axis is placed with the second of the three additional AUGMENTING dots for the 256 axis.

Status Field. Indicates status of T4005 and computer. Lights behind the negative-film labels illuminate when the indicated status is true.

(orange)	CONTROLLER ADDRESSED	(white)	INTERRUPT PENDING
(green)	PROCESSOR RUNNING	(red)	INTERRUPT DISABLED

CONTROLLER ADDRESSED

Indicates the T4005 has been addressed by the computer within the last 0.5 second.

INTERRUPT PENDING

Indicates the T4005 has requested an interrupt, but it has not yet been serviced.

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PROCESSOR RUNNING

Indicates the computer is running, not in a WAIT condition.

INTERRUPT DISABLED

Indicates the T4005 is incapable of initiating an interrupt because the Interrupt Control switch on the back of the T4005 (actually located on the Interface Unit's mounting plate) is in the DISABLED position, or is in the COMPUTER ENABLED position but the computer has not enabled the T4005's interrupt hardware.

Display Mode Control Field. Indicates current operating mode of the T4005. The READY, FRAME, and LOCATE modes are mutually exclusive so that only one button at a time can be lighted. Modes are selectable by pushing the buttons or under software control.

READY

Places the T4005 in a state to receive commands from the computer. If the READY mode is reached from the FRAME mode by pushing the READY button, the GDC is only potentially ready; that is, the Not Ready status flagged to the computer is removed. Three other conditions of the READY state have not yet occurred:

- 1) Erasure, if in AUTO ERASE.
- 2) Storage of the current DISPLAY SCALES.
- 3) Transfer of the Offset Registers' content into the Main Registers.

Receipt of any computer command addressed to the GDC is required to make the T4005 fully READY.

This two-step method of attaining READY allows the user to return to the FRAME mode, and still have a display and meaningful information in the Offset Registers and Last Scale Latches.

Attaining READY from the LOCATE mode is similar, in that erasure and updating of the Last Scale Latches is delayed. However, the Main Registers remain unchanged; i.e., Offset is not transferred into them.

If the READY state is achieved by pushing the RECALL or DISPLAY buttons, the T4005 is in a fully READY state.

FRAME

Places a write-thru frame on those Display Devices selected by the T4005. Relative to the display, the

Frame reflects the current DISPLAY SCALES by the Frame size and aspect ratio, and the current Offset by the position of the Frame's lower left-hand corner.

LOCATE

Places a write-thru Locator on those Display Devices selected by the T4005. The Locator is an L-shape with the length of each leg being approximately one-eighth of the screen axis. The Locator serves many uses. As a cursor, it locates the lower left-hand corner (0, 0) of a display to follow; this is, the point from which subsequent display commands (steps) will start. As a limited form of a graphic input, the Locator can be used in conjunction with software and the MODIFY button (button D) in the SOFTWARE CONTROL field. Pushing button D would cause a graphic input interrupt and the computer would then query the Offset and Main Registers for the precise address of the Locator (which could be anywhere in the basic matrix range of 8192 by 8192).

DISPLAY DEVICE Field. Indicates selected status of the Display Devices which are attached to the T4005 and powered up. Buttons I through IV can be assigned to various display devices. Button I is assigned to the T4005's slightly modified Type 611. The buttons function as push-ON, push-OFF selectors. If the assigned device is not connected to the T4005 or is not powered up, then its DISPLAY DEVICE light will not come on when the button is pushed. Pushing the OFF button cancels selection of all the devices. In this case, the GDC is in a non-ready state. Normally, the computer's software will query the T4005 as to its readiness. If the T4005 is not ready, the computer can do something else with the data, such as send it to a mechanical plotter.

OFFSET Field. Provides positioning control for the Frame and Locator and indicates which positioning mode is being used.

Four-Button Positioning Group

Steer the Frame or Locator around on those Display Devices selected by the T4005. If the Frame gets too far afield in the FRAME mode, backlighted arrows on the pushbuttons indicate in which direction the Frame disappeared. Should the Frame effectively surround the Display offscreen, then all the buttons would be lighted, signifying an ambiguous situation. None of the buttons are lighted in the LOCATE mode, as the Locator is restrained from leaving the display area.

FAST

Provides two speeds of positioning control. Pushing and lighting the FAST button selects a speed for rapidly and roughly placing the Frame or Locator. Turning the light off selects a Slow speed for precisely locating them with the positioning group buttons.

HOME

Indicates whenever the D/A converters are at 0, 0. Pushing the HOME button will light it momentarily while it returns the Frame or Locator to the lower left hand corner of the display.

SETUP Field. Pushing the INITIAL button sets the T4005 hardware to a predetermined, initializing state. See the initialization described for powering-up conditions under "Primary Power Switch". INITIAL is essentially a master clear button for the T4005.

OFFSET/SCALE Field:**RETAIN**

Places in storage registers the current DISPLAY SCALE values selected and the current contents of the X and Y axis Offset Registers.

RECALL

Places the contents of those special storage registers into the DISPLAY SCALE registers and the Offset Registers. In addition, it initiates a DISPLAY Interrupt and places the GDC in the READY mode.

ERASE Field:**AUTO**

Erases the selected DISPLAY DEVICE(s) when the DISPLAY or RECALL buttons are pushed or when the fully READY mode is reached upon receipt of a command addressed to the T4005. It also allows Conditional Erasures from the computer to erase the selected DISPLAY DEVICE(s). The AUTO button lights when the Auto mode is selected either by pushing the button or from software control.

MANUAL

Erases the selected DISPLAY DEVICE(s) any time it is pushed.

SOFTWARE CONTROL Field. Indicates which DISPLAY NUMBER is selected and which Interrupt Function has been requested. These buttons have very little hardware implication as they are intended to work exclusively with the software.

DISPLAY NUMBER 1 through 8

Indicates to the computer in a GDC Device Status Word which DISPLAY NUMBER the operator has chosen by pushing its button. Only one number at a time can be selected.

Interrupt Functions A through H

Causes an interrupt function when pushed, provided the interrupt structure has not been disabled. Subsequently, the computer requests the information via a DSW as to which button was pushed, and which DISPLAY NUMBER is currently selected.

Buttons A through H are intended to provide interrupt functions to the user. Any function can be assigned to any button by the software designer. The present labels appearing on the Graphic Display Controller panel relate specifically to the subroutines contained in the Tektronix-supplied software support package associated with the 015-0180-00 IBM 1130 Interface Unit.

There is a hardware option associated with Button H which is enabled with a jumper. Button H is labeled DISPLAY, and would normally be pushed to request a replay of a display. It places the T4005 in the READY mode and causes erasure of the display devices if the ERASE mode is in AUTO.

Display Unit

ERASE. Erases information previously written on the screen when the button is pushed. Pushbutton is lighted when the instrument is powered up.

VIEW. Switches instrument from the "hold" mode of very low intensity levels to the "view" mode. The instrument will stay in the "view" mode for 60 to 90 seconds after the VIEW switch has been pushed, or after receipt of the last Z axis signal. After that period, it will automatically switch to the "hold" mode.

INTENSITY. Sets intensity level of writing beam when the Z axis is activated.

FOCUS. Adjusts writing beam focus.

OPERATING LEVEL. Sets the target backplate voltage to the proper level for storage operation.

OL TP. Provides access to monitor the target backplate voltage while adjusting the OPERATING LEVEL.

TEST SPIRAL. Causes instrument to complete an erase cycle and store a single shot test pattern when pushed in and held in. Releasing the switch after the test pattern is stored has no effect on the display. Pulling the TEST SPIRAL switch out puts the instrument in a non-store

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mode, and the test pattern becomes repetitive for focusing and other tests.

Rear Panel

J101. Interfaces the Display Drivers to DISPLAY DEVICE I.

J102. Interfaces the Display Drivers to DISPLAY DEVICE II.

J103. Interfaces the Display Drivers to DISPLAY DEVICE III.

J104. Interfaces the Display Drivers to DISPLAY DEVICE IV.

J105, J106. Interface to functions as yet unassigned in the Auxiliary Area.

J152. Provides interlocked AC power to the Type 611 Storage Display Unit.

Line Voltage and Range Selector. Selects three voltage ranges for either 115 VAC or 230 VAC service. Automatically switches in proper line fuse.

NOTE

The Display Unit's Line Voltage and Range Selector inside the T4005 housing, on the rear of the Display Unit frame, performs the same function. At all times it must match the GDC's selector.

Display CRT Aging Characteristics

Monitor CRT's incorporate storage targets with increased secondary electron collection efficiencies, which eliminate trace-shadowing and improve the stability of the target. This improved stability is apparent in both extended view times and long term aging characteristics.

The following performance factors deserve particular note and apply for normal usage. (Refer to display instrument specifications for performance values):

Luminance: With normal usage, luminance levels are relatively stable with age, meeting or exceeding specified performance beyond the warranty period.

Contrast Ratio: With normal usage, contrast ratios generally increase to well above initial performance.

Dot Writing Time: Exceeds specified performance beyond warranty period with normal usage of the display area.

Normal usage is defined as uniform use of all parts of the display area. The area of the target in which displays are located should be shifted periodically to maintain stable target aging characteristics. The percent-written area should not exceed that specified for the particular instrument.

Safety Considerations

The T4005 primary power circuitry ties two distinct units, the slightly modified Type 611 and the 4201 Graphic Display Controller, to one primary power switch and one power cord in an interlocked fashion. This allows the units to be protected simultaneously against application of the wrong line voltage, to be separated relatively easily, and allows the T4005 to meet UL specifications. Line Voltage Selector blocks in both the modified 611 and the GDC portion of the T4005 have provisions to make sure both selectors match before primary power can be applied to the 611. Relatively quick disconnect and conformance to UL specifications is satisfied by having the power disconnects held in place by machine screws.

The instrument is provided with a three-wire power cord with a three-terminal, polarized plug for connection to the power source. The grounding terminal of the plug is directly connected to the instrument frame as recommended by national and international safety codes. Color coding of cord conductors follows the National Electrical Code (ANSI C-1 1968) which specifies: Line, black; Neutral, white; Safety Earth or Ground, green with a yellow stripe.

WARNING

The instrument is intended to be operated from a single-phase power source which has one of its current-carrying conductors (the Neutral Conductor) at ground (earth) potential. Operation from other power sources where both current-carrying conductors are live with respect to ground (such as phase-to-phase on a multi-phase system, or across the legs of a 117-234 V single-phase three-wire system) is not recommended, as only the Line Conductor has over-current (fuse) protection within the instrument.

ELECTRICAL CHARACTERISTICS

4201 GRAPHIC DISPLAY CONTROLLER
ELECTRONICS

Parameter	Performance Limits	
GDC Setup Time		
Without AUTO ERASE	10 μ s or less from leading edge of setup command pulse.	
With AUTO ERASE	Equal to erase period of the Display Device selected.	
Real Time Clock Rates		
From Line Source	At line frequency.	
From External Source		
Frequency	500 kHz or less.	
Pulse Width	At least 25 ns.	
	Two lines must be activated in the Accessory Area:	
	60 Hz DISABLE Requires a level to drive one T ² L load.	
	EXT CLOCK IN Requires a pulse to drive one T ² L load.	
Erase Pulse to Display Controllers	T ² L pulse at least 15 μ s duration.	
Aux. Write Z-Axis Pulse	T ² L pulse at least 200 ns duration.	
Mode Switching Time	150 ms to 250 ms to reach LOCATOR mode from any other mode by manual or computer command.	
READY Mode		
Plotting Mode	Incremental. 1024 levels/axis maximum (in display scale 8 K).	
Plotting Speed	1,000,000 increments/sec maximum. Actual plotting speed determined by display device Settling and Dot Writing Times.	
Full-Scale Position Register Levels	DISPLAY SCALE	Positions Per Axis
	8 K	8192
	4 K	4096
	2 K	2048
	1 K	1024
	512	512
	256	256

Parameter	Performance Limits		
256 SKIP AHEAD MODE	DISPLAY SCALE	256 SKIP AHEAD Positions	+ Normal Positions
	8 K	31	256
	4 K	15	256
	2 K	7	256
	1 K	3	256
	512	1	256
	256	0	256
DISPLAY DEVICE Formats			
For DISPLAY SCALEs 8K, 4K, 2K and 1K	1024 levels/axis.		
For DISPLAY SCALE 512	512 levels/axis.		
For DISPLAY SCALE 256	256 levels/axis.		
When AUGMENT-ing	1024 levels/axis.		
DISPLAY SCALE 512	1 augmented point for every one CPU-generated point.		
DISPLAY SCALE 256	3 augmented points for every one CPU-generated point.		
D/A Converter Staircase			
Range	0 V to +2.5 V in consecutive levels.		
Full Scale Accuracy			
For DISPLAY SCALEs 8K, 4K, 2K and 1K	Within 3%, in 1024 consecutive levels.		
For DISPLAY SCALE 512	Within 3%, in 512 consecutive levels.		
For DISPLAY SCALE 256	Within 3%, in 256 consecutive levels.		
Increment Accuracy	$\pm 1/2$ level or less, within 1/2 LSB, between any two consecutive levels.		
D/A Settling Time	1 μ s or less, to within 1/2 LSB.		
LOCATOR Mode			
Size	One-eighth display screen size. "L"-shaped.		

Parameter	Performance Limits		
Position Range	DISPLAY SCALE	Positions Per Axis	
	8 K	1024	
	4 K	1024	
	2 K	1024	
	1 K	1024	
	512	512	
	256	256	
Position Rate	DISPLAY SCALE	Normal Mode	FAST Mode
	8 K	25 ms/pos	4 ms/pos
	4 K	150 ms/pos	8 ms/pos
	2 K	100 ms/pos	16 ms/pos
	1 K	200 ms/pos	32 ms/pos
	512	400 ms/pos	64 ms/pos
	256	800 ms/pos	128 ms/pos
Time to HOME	10 μ s after Mode Switching time.		
FRAME Mode	Determined by ratio of last DISPLAY SCALE selected in the READY mode and new DISPLAY SCALE selected in the FRAME mode. Vertical and horizontal frame scales are independent.		
Size			

Parameter	Performance Limits		
Accuracy	Within 3% of display axis.		
Usable Aspect Ratio	32:1.		
Typical			
Maximum	64:1.		
Time to HOME	150 ms, maximum, for the Frame to reposition its lower left corner to the display screen's lower left corner.		
Position Range	DISPLAY SCALE	Positions Per Axis	
	8 K	± 512	
	4 K	± 256	
	2 K	± 128	
	1 K	± 64	
	512	± 32	
	256	± 16	
Positioning Rate	DISPLAY SCALE	Normal Mode	FAST Mode
	8 K	25 ms/pos	4 ms/pos
	4 K	50 ms/pos	8 ms/pos
	2 K	100 ms/pos	16 ms/pos
	1 K	200 ms/pos	32 ms/pos
	512	400 ms/pos	64 ms/pos
	256	800 ms/pos	128 ms/pos

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GDC Signal Name	Interconnect Board Pin #	TTL Drive Req.	Signal* Type	Min. Pulse Width	Line Function
Input Lines to the GDC (Control Lines)					
$\overline{\text{SHIFT}}$	J131-18	1	P	25 ns	Shifts the Display Device effective screen one-fourth of a screen width left (horizontal format screen) or down (vertical format screen).
$\overline{\text{SLANT}}$	J130-4	1	P	25 ns	Shifts the horizontal axis proportional to a change in the vertical axis.
$\overline{\text{LOCATOR GEN ON}}$	-3	1	P	25 ns	Turns on the Locator generator, overriding the Mode selection.
$\overline{\text{FRAME GEN ON}}$	-19	1	P	25 ns	Turns on the Frame generator, overriding the Mode selection.
$\overline{\text{LOCATE MODE}}$	-22	1	P	25 ns	Puts the GDC in the Locate Mode.

*P = Pulse
L = Level

4201 INPUT/OUTPUT INTERFACE BUS (cont.)

GDC Signal Name	Interconnect Board Pin #	TTL Drive Req.	Signal* Type	Min. Pulse Width	Line Function
FRAME MODE	J130-23	1	P	25 ns	Puts the GDC in the Frame Mode.
READY MODE	-24	1	P	25 ns	Puts the GDC in the Ready Mode.
VERT AUG	-21	2	P	25 ns	Turns off the Augment function in the vertical axis.
VERT 8 K	J131-1	1	P	25 ns	Sets vertical DISPLAY SCALE to 8K.
VERT 4 K	-3	1	P	25 ns	Sets vertical DISPLAY SCALE to 4 K.
VERT 2 K	-4	1	P	25 ns	Sets vertical DISPLAY SCALE to 2 K.
VERT 1 K	-12	1	P	25 ns	Sets vertical DISPLAY SCALE to 1 K.
VERT 512	-13	1	P	25 ns	Sets vertical DISPLAY SCALE to 512.
VERT 256	-11	1	P	25 ns	Sets vertical DISPLAY SCALE to 256.
LOWER SCREEN ERASE	J133-3	TBD	P	25 ns	Erases lower screen only of a split screen Display Device.
LOWER SCREEN NON-STORE	-2	TBD	P	25 ns	Sets lower screen of a split screen Display Device to a non-store mode.
AUTO ERASE SET	J130-2	2	P	25 ns	Sets the GDC to AUTO ERASE.
CONDITIONAL ERASE	-1	1	P	25 ns	Causes a Display Device erase command if the GDC is set to AUTO ERASE.
ERASE	-18	1	P	25 ns	Causes GDC to generate an erase command.
WRITE THROUGH	J133-19	1 per device	P	25 ns	Sets a Display Device to a write-through mode.
VIEW	-20	1 per device	P	25 ns	Sets a Display Device to a viewing mode.
FUNCTION RESET	J130-20	1	P	25 ns	Resets GDC functions Shift, Slant, Locator Gen On, Frame Gen On, Vert Aug, Horiz Aug, Lower Screen Non-Store, Auto Erase Set, Write Through and View.
HORIZ AUG	J131-2	2	P	25 ns	Turns off the Augment function in horizontal axis.
HORIZ 8 K	-29	1	P	25 ns	Puts horizontal DISPLAY SCALE to 8 K.

*P = Pulse
L = Level

4201 INPUT/OUTPUT INTERFACE BUS (cont.)

GDC Signal Name	Interconnect Board Pin #	TTL Drive Req.	Signal* Type	Min. Pulse Width	Line Function
HORIZ 4 K	J131-28	1	P	25 ns	Puts horizontal DISPLAY SCALE to 4 K.
HORIZ 2 K	-27	1	P	25 ns	Puts horizontal DISPLAY SCALE to 2 K.
HORIZ 1 K	-25	1	P	25 ns	Puts horizontal DISPLAY SCALE to 1 K.
HORIZ 512	-26	1	P	25 ns	Puts horizontal DISPLAY SCALE to 512.
HORIZ 256	-24	1	P	25 ns	Puts horizontal DISPLAY SCALE to 256.
CLOCK DISABLE	-19	1	P	25 ns	Turns off internal real-time clock.
CLOCK ENABLE	-20	1	P	25 ns	Turns on internal real-time clock.
SOFTWARE INITIAL	-6	1	P	25 ns	See Reset Functions, Table 1-1.
+X Strobe	-30	2	P	25 ns	Increments the horizontal position register.
−X Strobe	-31	2	P	25 ns	Decrements the horizontal position register.
+Y Strobe	-34	2	P	25 ns	Increments the vertical position register.
−Y Strobe	J130-31	2	P	25 ns	Decrements the vertical position register.
BEAM ON	-34	2	L		Enables the Z axis circuit.
SELECT DEVICES	J132-19	2 per device	P	Table 1-3	Strobe to GDC to select a DISPLAY DEVICE according to CPU Bits 8–15 coding. See Table 1-2.
ADDRESSED	J131-21	2	P	100 ns	Lights the control panel read-out, indicating the GDC has been addressed within the last 0.5 second.
CPU SELECT LIGHTS	-23	1	P	Table 1-3	Strobe to GDC to select SOFTWARE CONTROL lights A–H according to CPU Bits 8–15 coding. See Table 1-2.
SELECT STATUS WORD	J132-1	2	P	Table 1-3	Strobe to GDC to select a status word according to CPU Bits 8–15 coding. See Table 1-2.

*P = Pulse
L = Level

4201 INPUT/OUTPUT INTERFACE BUS (cont.)

GDC Signal Name	Interconnect Board Pin #	TTL Drive Req.	Signal* Type	Min. Pulse Width	Line Function
STATUS WORD RESET	J133-18	2	P	25 ns	Strobe to turn off previously selected status word.
BUTTON INTERRUPT RESET	-1	2	P	200 ns	Resets the software button A—H interrupt latch, turning off the interrupt.
CLOCK INTERRUPT RESET	J131-22	1	P	25 ns	Resets the real-time clock interrupt latch, turning off the interrupt.
SKIP AHEAD	-14	2	P	Table 1-3	Steers the +X, -X, +Y and -Y Strobe pulses ahead in the position registers equal to 256 levels.
AUX WRITE	-16	1	P	Table 1-3	Special control strobe.
CPU Bit 8	J132-16	5	L	Table 1-3	Contain the selection coding to be used in conjunction with the appropriate Strobes for controlling the GDC functions. See Table 1-2.
9	J133-21	5			
10	-4	4			
11	-5	5			
12	J132-15	4			
13	-18	4			
14	-14	4			
15	J133-22	4			
CPU Bit 9 LATCHED	J131-15	1	L	Table 1-3	Data bit lines used in conjunction with the AUX WRITE Strobe.
CPU Bit 10 LATCHED	-33	1			
CPU Bit 11 LATCHED	-17	1			
READY • NOT BUSY • NOT OFF	J132-24	1	L		Sends status data to Status Word Selector circuit.
GDC SETUP	J130-7	1	P	25 ns	Sets the GDC to a full READY condition and generates a Display Device erase command.
BUTTON INTERRUPT DISABLED	J132-25	1	L		Sends status data to Status Word Selector circuit.
INTERRUPT DISABLE LIGHT	J130-33	38	L		Turns on panel INTERRUPT DISABLED indicator.
PROCESSOR RUNNING LIGHT	-32	38	L		Turns on panel PROCESSOR RUNNING indicator.
CPU RESET	-14	2	L		Turns off software lights. Resets clock interrupt and disables clock.

*P = Pulse
L = Level

4201 INPUT/OUTPUT INTERFACE BUS (cont.)

GDC Signal Name	Interconnect Board Pin #	TTL Fan-Out	Signal * Type	Min. Pulse Width	Line Function
Output Lines from the GDC					
BUTTON INTERRUPT REQUEST	J132-20	10	L		Indicates a button interrupt has been requested.
CLOCK INTERRUPT REQUEST	J130-15	9	L		Indicates the real time clock has interrupted.
P.O. RESET + INITIAL	-16	19	P	1 ms	Indicates a reset condition.
SETTING UP	J131-32	1	L		Indicates the GDC has received a GDC SETUP command and is completing the Ready process.
X + Y SKIP INC.	J130-5	4	P	400 ns	Indicates the X or Y position registers are skipping ahead incrementally.
WAIT	-17	10	L		Indicates the GDC is busy. An input increment is being processed or that a Display Device is being erased.
READY • NOT OFF	-6	10	L		Indicates GDC status is READY mode and at least one Display Device selected.
STATUS WORD BIT	0 J132-26 1 J133-15 2 -16 3 -17 4 -34 5 -33 6 -32 7 J132-17 8 -34 9 -33 10 -32 11 -31 12 -30 13 -29 14 -28 15 -27 16 J133-24 17 J132-7 18 J133-27 19 -25 20 -28 21 J132-10 22 J133-26 23 -23	5	L		Data lines transmit GDC status to the CPU via the Interface Unit. The Status Word Bits are arranged in 8, 12, 16 or 24 bits per word for tailoring to the particular CPU word length. (This word length is selected by Status Word Selector Card Acc-12 in the GDC). See Table 1-4 for Status Word Bit assignments.

*P = Pulse
L = Level

TABLE 1-1
INITIALIZATION OR RESET FUNCTIONS

Command	Source	Actions
INITIAL and "Initial"	T4005 Panel	1. Clears Offset registers. 2. Clears Main registers. 3. Sets GDC to READY.
	Software	4. Enables an Erase flip-flop for automatic erasing. 5. Turns on Vertical and Horizontal AUGMENT. 6. Turns off AUTO ERASE. 7. Forces pre-set DISPLAY SCALES. 8. Sets Last Plot latches equal to the pre-set DISPLAY SCALE. 9. Resets pending button interrupts. 10. Clears Write through (611 Display Controller only). 11. Clears View (611 Display Controller only). 12. Clears Frame Gen. On. 13. Clears Locator Gen. On. 14. Clears Slant. 15. Clears Shift. 16. Resets Status Word Selector. 17. Turns off Software lights A–H. 18. Provides clearing signal to Interface Unit.

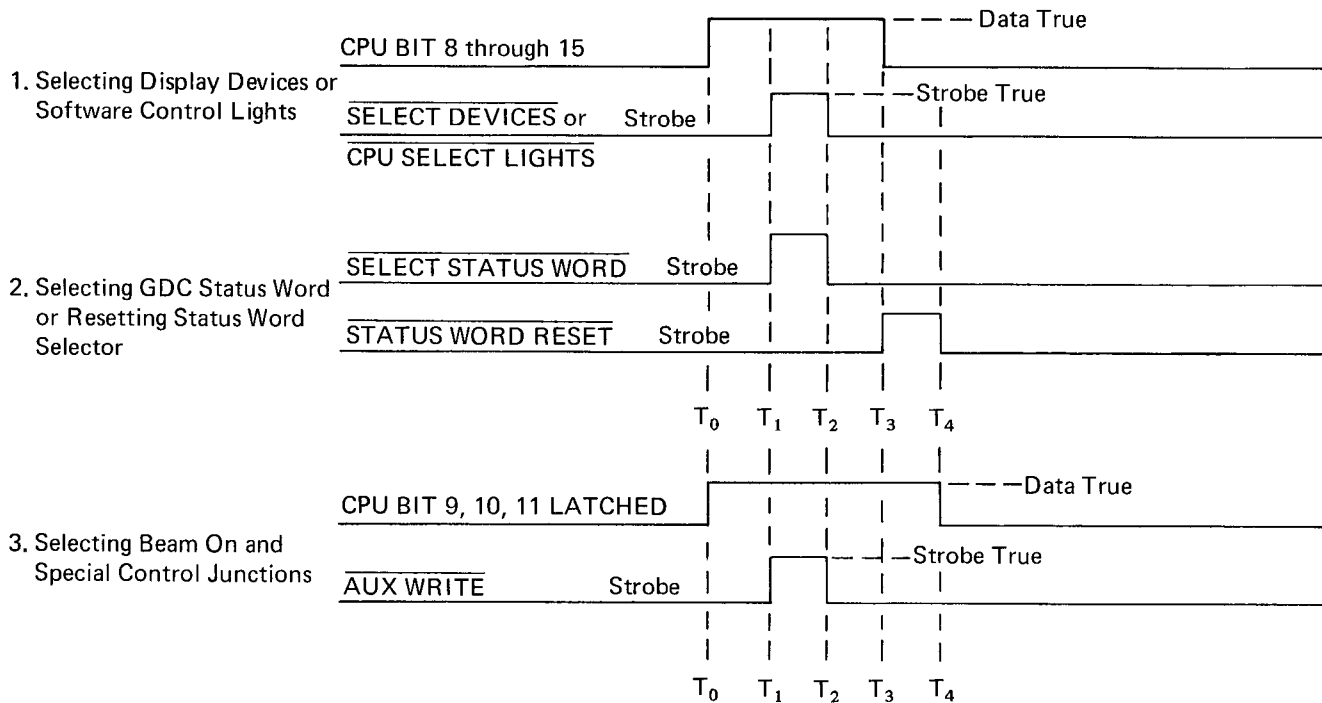
TABLE 1-1 (cont.)

Command	Source	Actions
Power On Reset	T4005 Power Switch	1. Same as Initial, plus. 2. Disables Real Time Clock. 3. Resets pending clock interrupts. 4. Selects DISPLAY DEVICES turned On. 5. Loads "Initial" conditions into the RETAIN/RECALL registers. 6. Disables Computer Interrupt Enable/Disable circuitry.
"Function Reset"	Software	1. AUGMENT On. 2. Clears AUTO ERASE. 3. Clears Shift. 4. Clears Slant. 5. Clears Frame Gen. On. 6. Clears Locator Gen. On. 7. Clears Write through. 8. Clears View.
"CPU Reset"	CPU Panel Pushbutton	1. Disables Real Time Clock. 2. Resets pending clock interrupts. 3. Turns off Software lights A–H. 4. Clears pending button interrupts.

TABLE 1-2
4201 Input/Output Interface Bus

Operation	Activated Control Line	CPU Data Bits								Function	
		8	9	10	11	12	13	14	15	Display Controller Affected	Mode
1. Display Controller Selection	<u>SELECT DEVICES</u>	0	0	0	0	0	0	0	0	No change	--
		1	0	0	0	0	0	0	0	Turn On #1	Store
		0	1	0	0	0	0	0	0	Turn On #1	Non-Store
		0	0	1	0	0	0	0	0	Turn On #2	Store
		0	0	0	1	0	0	0	0	Turn On #2	Non-Store
		0	0	0	0	1	0	0	0	Turn On #3	Store
		0	0	0	0	0	1	0	0	Turn On #3	Non-Store
		0	0	0	0	0	0	1	0	Turn On #4	Store
		0	0	0	0	0	0	0	1	Turn On #4	Non-Store
		1	1	0	0	0	0	0	0	Turn Off #1	--
		0	0	1	1	0	0	0	0	Turn Off #2	--
		0	0	0	0	1	1	0	0	Turn Off #3	--
		0	0	0	0	0	0	1	1	Turn Off #4	--
		1	1	1	1	1	1	1	1	Turn Off #1, 2, 3, & 4	--
2. Select GDC Status Word (See Table 1-4 For Status Word Contents)	<u>SELECT STATUS WORD</u>	0	0	0	0	0	0	0	0	Select Status Word 0	
		0	0	0	1	0	0	0	0	Select Status Word 1	
		0	0	1	0	0	0	0	0	Select Status Word 2	
		0	0	1	1	0	0	0	0	Select Status Word 3	
		0	1	0	0	0	0	0	0	Select Status Word 4	
		0	1	0	1	0	0	0	0	Select Status Word 5	
		0	1	1	0	0	0	0	0	Select Status Word 6	
		0	1	1	1	0	0	0	0	Select Status Word 7	
		1	0	0	0	0	0	0	0	Select Status Word 8	
		1	0	0	1	0	0	0	0	Select Status Word 9	
		1	0	1	0	0	0	0	0	Select Status Word 10	
		1	0	1	1	0	0	0	0	Select Status Word 11	
3. Select Software Controller Button Lights	<u>CPU SELECT LIGHTS</u>	1	0	0	0	0	0	0	0	Turn On button A light	
		0	1	0	0	0	0	0	0	Turn On button B light	
		0	0	1	0	0	0	0	0	Turn On button C light	
		0	0	0	1	0	0	0	0	Turn On button D light	
		0	0	0	0	1	0	0	0	Turn On button E light	
		0	0	0	0	0	1	0	0	Turn On button F light	
		0	0	0	0	0	0	1	0	Turn On button G light	
		0	0	0	0	0	0	0	1	Turn On button H light	
		1	1	1	1	1	1	1	1	Turn On all button lights	
		0	0	0	0	0	0	0	0	Turn Off all button lights	
4. Beam On and Special Control	<u>AUX WRITE</u>	1	0	0	0	0	0	0	0	Write the dot (beam on)	
		1	0	0	1	0	0	0	0	Unassigned functions	
		1	0	1	0	0	0	0	0		
		1	0	1	1	0	0	0	0		
		1	1	0	0	0	0	0	0		
		1	1	0	1	0	0	0	0		
		1	1	1	0	0	0	0	0		
		1	1	1	1	0	0	0	0		

TABLE 1-3
Data and Strobe Pulse Timing Relationships



NOTES

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

TABLE 1-4

Card	Gate	Bit	Name	WORD SIZE (bits)			
				8	12	16	24
Acc-11	A	8a-0	Ready Not Busy & Device Sel	DSW 0	DSW 0	DSW 0	DSW 0
		8a-1	Device Selected	↓	↓	↓	↓
		8a-2	Button Interrupt Disabled	↓	↓	↓	↓
		8a-3	Auto Erase On	↓	↓	↓	↓
		8a-4	Horiz Augment On	↓	↓	↓	↓
		8a-5	Vert Augment On	↓	↓	↓	↓
		8a-6	Shifted	↓	↓	↓	↓
		8a-7	Slanted	↓	↓	↓	↓
		4a-0	Frame Generator On	DSW 1	↓	↓	↓
		4a-1	Locator Generator On	↓	↓	↓	↓
		4a-2	Button Interrupt Number Bit 4	↓	↓	↓	↓
		4a-3	Button Interrupt Number Bit 2	↓	↓	↓	↓
		4'a-0	Button Interrupt Number Bit 1	↓	DSW 1	↓	↓
		4'a-1	Plot Number Bit 4	↓	↓	↓	↓
		4'a-2	Plot Number Bit 2	↓	↓	↓	↓
		4'a-3	Plot Number Bit 1	↓	↓	↓	↓
		8b-0	Ready Mode	DSW 2	↓	DSW 1	↓
		8b-1	Frame Mode	↓	↓	↓	↓
		8b-2	Locate Mode	↓	↓	↓	↓
		8b-3	Device 1 On	↓	↓	↓	↓
		8b-4	Device 2 On	↓	↓	↓	↓
		8b-5	Device 3 On	↓	↓	↓	↓
		8b-6	Device 4 On	↓	↓	↓	↓
		8b-7	X-Y Analog Recorder	↓	↓	↓	↓
		4b-0	Storage Type 1	DSW 3	DSW 2 (1 of 2)	↓	DSW 1
		4b-1	Storage Type 2	↓	↓	↓	↓
		4b-2	Storage Type 3	↓	↓	↓	↓
		4b-3	Storage Type 4	↓	↓	↓	↓
		4'b-0	Non-Store Type 1	↓	↓	↓	↓
		4'b-1	Non-Store Type 2	↓	↓	↓	↓
		4'b-2	Non-Store Type 3	↓	↓	↓	↓
		4'b-3	Non-Store Type 4	↓	↓	↓	↓
Acc-10	B	8a-0	XP4	DSW 4	DSW 3	DSW 2	↓
		8a-1	XP2	↓	↓	↓	↓
		8a-2	XP1	↓	↓	↓	↓
		8a-3	XM12	↓	↓	↓	↓
		8a-4	XM11	↓	↓	↓	↓
		8a-5	XM10	↓	↓	↓	↓
		8a-6	XM9	↓	↓	↓	↓
		8a-7	XM8	↓	↓	↓	↓
		4a-0	XM7	DSW 5	↓	↓	↓
		4a-1	XM6	↓	↓	↓	↓
		4a-2	XM5	↓	↓	↓	↓
		4a-3	XM4	↓	↓	↓	↓
		4'a-0	XM3	↓	DSW 5 (1 of 3)	↓	↓
		4'a-1	XM2	↓	↓	↓	↓
		4'a-2	XM1	↓	↓	↓	↓
		4'a-3	XM0	↓	↓	↓	↓

TABLE 1-4 (cont)

Card	Gate	Bit	Name	WORD SIZE (bits)				
				8	12	16	24	
Acc-10	B	8b-0	YP4	Vertical Present Scale Size	DSW 6 ↓	DSW 4 ↓	DSW 3 ↓	DSW 2 ↓
		8b-1	YP2					
		8b-2	YP1					
		8b-3	YM12					
		8b-4	YM11					
		8b-5	YM10					
		8b-6	YM9					
		8b-7	YM8					
		4b-0	YM7	Vertical Main Position Register Bits	DSW 7 ↓	DSW 5 (2 of 3) ↓		
		4b-1	YM6					
		4b-2	YM5					
		4b-3	YM4					
		4'b-0	YM3					
		4'b-1	YM2					
		4'b-2	YM1					
		4'b-3	YM0					
Acc-9	C	8a-0	XL4	Horizontal Last Plot Scale	DSW 8 ↓	DSW 6 ↓	DSW 4 ↓	
		8a-1	XL2					
		8a-2	XL1					
		8a-3	X Offset 12	Horizontal Offset Register	DSW 9 ↓	DSW 2 (2 of 2) ↓		
		8a-4	X Offset 11					
		8a-5	X Offset 10					
		8a-6	X Offset 9					
		8a-7	X Offset 8					
		4a-0	X Offset 7	SPARE	DSW 10 ↓	DSW 7 ↓	DSW 5 ↓	
		4a-1	X Offset 6					
		4a-2	X Offset 5					
		4a-3	X Offset 4					
		4'a-0		Vertical Last Plot Scale	DSW 11 ↓	DSW 5 (3 of 3) ↓		
		4'a-1						
		4'a-2						
		4'a-3		Vertical Offset Register Bits				
		8b-0	YL4					
		8b-1	YL2					
		8b-2	YL1					
		8b-3	Y Offset 12					
		8b-4	Y Offset 11					
		8b-5	Y Offset 10					
		8b-6	Y Offset 9					
		8b-7	Y Offset 8	SPARE				
		4b-0	Y Offset 7					
		4b-1	Y Offset 6					
		4b-2	Y Offset 5					
		4b-3	Y Offset 4					
		4'b-0						
		4'b-1						
		4'b-2						
		4'b-3						

DISPLAY CONTROLLERS

Parameter	Performance Limits
Outputs from Controllers	
Display Format	
Type 611	Set to 16.2 cm by 16.2 cm, within 2%.
Horizontal Format	Positioned to right side.
Vertical Format	Positioned to top.
Type 601	Set to 8 cm by 8 cm, within 2%. Positioned to right side.
Display Shift	
Horizontal Format	Shifts 1/4-screen left, within 1%.
Vertical Format	Shifts 1/4-screen down, within 1%.
Display Slant	
X and Y Analog Outputs	0 V to +1.0 V full scale, within 3%.
Z Axis Pulse	+0.4 V or less to at least 2.4 V.
Maximum Amplitude	+5.5 V.
Pulse Width	5 μ s, within 10%.
Non-Store Command	Between +1.4 V and +1.6 V at low level to at least 10 V.
View Command	+0.4 V or less to at least 10 V.
Write-Through Command	+0.4 V or less to at least 10 V.
Monitor Erase Pulse	+0.4 V or less to 15 V, within 5%.
Pulse Width	10 μ s, -0%, +50%.
Output Control Line Logic	These lines are TTL-compatible: 1) Non-Storage Type identification rails. 2) Storage Type identification rails. 3) X-Y Analog Recorder identification rails. 4) <u>DEVICE ON</u> . 5) <u>DEVICE LITE</u> 6) <u>WRITING + ERASE</u>

DISPLAY CONTROLLERS (cont.)

Parameter	Performance Limits	
Inputs to Controllers		
X and Y Staircase from GDC D/A Converters		
Range	0 V to +2.5 V in 1024 consecutive steps (one step = one LSB). Positive positioning decreases analog voltage.	
Accuracy		
Full Scale	Within 3%.	
Incremental	Within 1/2 LSB between any two consecutive steps.	
Erase Interval Pulse	+0.5 V or less to between +3.5 V and +6.0 V.	
Pulse Width	Equal to erase time of display device.	
Regulated DC Supplies	Accuracy	Maximum Allowable Load
-15 V	Within 0.75%.	25 mA
+15 V	Within 0.75%.	25 mA
+5 V	Within 1.5%.	175 mA
DEVICE SW Command	Normally open circuit. Function activated by switch closure to +5.0 V.	
Input Control Line Logic	TTL levels or pulses.	
Pulse Width Requirements		
<u>ERASE</u>	10 μ s, -0%, +50%.	
<u>WRITE</u>	At least 25 ns.	
<u>SELECT DEVICES</u>	At least 25 ns.	
<u>POWER ON RESET</u>	100 ms, -0%, +50%.	
X + Y SKIP INC	At least 25 ns.	
Δ LSB	At least 100 ns.	
<u>FRAME/LOCAL UNBLK</u>	1 μ s, within 10%.	

DISPLAY CONTROLLER INTERFACES

Parameter	Performance Limits	
	<p>GDC Sockets Acc-5, -6, -7, & -8 have identical interface connection assignments with exceptions noted for pins with varying uses, dependent on type of device being controlled.</p> <p>The different kinds of Display Controller cards available will not all necessarily use or provide the same signals as defined below. For instance, a 611 Display Controller card would use Pin 7 to provide an erase pulse and Pin 12 as its identification rail. An Oscilloscope Display Controller would use Pin 7 to erase the upper screen of a split-screen storage tube and Pin 10 as its identification rail.</p>	
Signal Name	Socket Pin	Line Function
Outputs from Controllers		
X OUTPUT	1	Analog output to display device horizontal input.
— X	2	Differential X analog output.
SX	3	X amplifier signal ground.
Y OUTPUT	4	Analog output to display device vertical input.
— Y	5	Differential Y analog output.
SY	6	Y amplifier signal ground.
$\overline{\text{DEVICE ERASE}}$	7	Erase pulse for monitor. Used with Type 3 and 4 devices.
$\overline{\text{ERASE UPPER}}$	7	Erase upper screen pulse for split-screen oscilloscopes.
C1	7	Timing capacitor connection for an X-Y recorder.
$\overline{\text{DEVICE NON-STORE}}$	8	Logic signal to set monitor to non-store mode.
$\overline{\text{STORE UPPER}}$	8	Logic signal to set upper screen to store mode.
C2	8	Timing capacitor connection for an X-Y recorder.

Signal Name	Socket Pin	Line Function
$\overline{\text{NON-STORE TYPE}}$	9	Identifies Display Device to GDC logic as a non-storing Type 1 or a Type 1 in the non-store mode. Type 1 devices not yet determined.
$\overline{\text{NON-STORE TYPE}}$	10	Identifies Display Device to GDC logic as a non-storing Type 2 or a Type 2 in a non-store mode. Type 2 assigned to oscilloscopes.
$\overline{\text{NON-STORE TYPE}}$	11	Identifies Display Device to GDC logic as a non-storing Type 3 or a Type 3 in the non-store mode. Type 3's are 601, 602 and 4501.
$\overline{\text{NON-STORE TYPE}}$	12	Identifies Display Device to GDC logic as a Type 4 in the non-store mode. Type 4 currently assigned to the 611 only.
DEVICE ON	13	Indicates to GDC logic the display device is electronically "turned on" and selected. Acc 5 = Device I on Acc-6 = Device II on Acc-7 = Device III on Acc-8 = Device IV on
X-Y RE CORDER	14	Indicates an X-Y Recorder is "on" and selected.
$\overline{\text{STORE LOWER}}$	A	Logic signal to set lower screen to store mode.
C3	A	Timing capacitor connection for an X-Y recorder.
VIEW	B	Logic signal to a storage monitor to go to the View mode.
$\overline{\text{ERASE LOWER}}$	B	Erase lower screen pulse for split-screen oscilloscopes.
R _t	B	Timing resistor connection for an X-Y recorder.
ANALOG GROUND	C	Current sink for all analog signal grounds.

Signal Name	Socket Pin	Line Function
<u>WRITE THRU</u>	D	Logic signals to a Type 4 to go to the Write Through mode.
F5	D	Fused +5 V Supply.
<u>WRITE ONLY</u>	E	Logic signal to 4501 to go to the Write Only Mode.
<u>TIMING GROUND</u>	E	Ground return for external R & C timing components for an X-Y recorder.
<u>SHIELD</u>	F	Z axis shield ground.
<u>UNBLANK</u>	H	Logic signal to turn on the Z axis in a negative logic system.
<u>UNBLANK</u>	J	Logic signal to turn on the Z axis in a positive logic system.
<u>STORE TYPE</u>	K	Identifies Display Device to GDC logic as a storage type 1 in store mode.
<u>STORE TYPE</u>	L	Identifies Display Device to GDC logic as a storage type 2 in store mode.
<u>STORE TYPE</u>	M	Identifies Display Device to GDC logic as a storage type 3 in store mode.
<u>STORE TYPE</u>	N	Identifies Display Device to GDC logic as a storage type 4 in store mode.
<u>GROUND</u>	R	Power supply ground return.
<u>DEVICE LITE</u>	W	Turns on the appropriate front panel DISPLAY DEVICE light. Acc-5 = Device I Acc-6 = Device II Acc-7 = Device III Acc-8 = Device IV
<u>WRITING + ERASE</u>	CC	Busy signal to GDC logic indicating Display Device is either writing or erasing.
Inputs to Controllers		
X D/A OUTPUT	15	Horizontal analog signal from GDC D/A converters.
Y D/A OUTPUT	16	Vertical analog signal from GDC D/A converters.

Signal Name	Socket Pin	Line Function
SHIFT	17	Logic signal causing the display format to shift 1/4-screen left in a horizontal format or 1/4-screen down in a vertical format.
CPU BIT 8, 10, 12, 14	18	CPU BIT 8 to Acc-5. CPU BIT 10 to Acc-6. CPU BIT 12 to Acc-7. CPU BIT 14 to Acc-8. Control lines used with SELECT DEVICE strobe. See coding in Table 1-2.
DEVICE SW	19	Signal from front panel controls to turn on/off selected Display Devices. Acc-5 = Device I Acc-6 = Device II Acc-7 = Device III Acc-8 = Device IV
<u>ERASE</u>	20	Logic signal to initiate an erase pulse.
CPU BIT 9, 11, 13, 15	21	CPU BIT 9 to Acc-5. CPU BIT 11 to Acc-6. CPU BIT 13 to Acc-7. CPU BIT 15 to Acc-8. Control lines used with SELECT DEVICE store. See coding in Table 1-2.
<u>WRITE</u>	22	Logic signal to initiate a Z axis pulse.
IN SECTOR	23	Logic signal indicating when the plotting position is within the selected sector. Z axis pulse inhibited when plot position is not in sector. (Line not used with type 3's.)
READY MODE	24	Flag from GDC logic.
<u>SELECT DEVICES</u>	25	Command to control the on/off, store/non-store state of a display device. See Table 1-2 for coding.
P.O. RST	26	Reset signal during Power On time.
RESET	27	Indicates a Power On Reset, a Function Reset, or an Initial condition.

Signal Name	Socket Pin	Line Function
$\overline{\text{CPU LOWER ERASE}}$	28	Computer-initiated command to erase lower screen of a split-screen oscilloscope.
$\overline{\text{ERASE INTERVAL}}$	A	Monitors display device erase time.
-15 V	P	Regulated -15 V supply.
+5 V	S	Regulated +5 V supply.
+15 V	T	Regulated +15 V supply.
SLANT	U	Logic signal causing display format to slant in the positive horizontal direction.
$\overline{\text{DEVICE OFF}}$	V	Control signal from front panel DISPLAY DEVICE OFF button.
$\overline{\text{CPU VIEW}}$	X	Computer-initiated command to generate a VIEW signal to a display device. Overrides a Hold mode.
$\overline{\text{CPU WRITE THRU}}$	Y	Computer-initiated command to generate a WRITE-THRU signal to a display device.
X + Y SKIP INC	Z	Initiates a delay time and busy flag, allowing for the slew time of a 256 skip command and resulting display device settling time.
ΔLSB	AA	Indicates when the plotting data has caused a change in the LSB position of the 1024 D/A converters. For use with an X-Y Recorder.
$\overline{\text{FRAME/LOCATOR UNBLK}}$	BB	FRAME or LOCATOR Mode signal for Z axis control.
$\overline{\text{BEAM ON BUFFER}}$	DD	Control signal to turn on the Z axis.
$\overline{\text{CPU LOWER NON-STORE}}$	FF	Computer-initiated command to set a storage oscilloscope lower screen to non-store.

DISPLAY DEVICE (TYPE 611)

Parameter	Performance Limits
Vertical and Horizontal Deflection System	
Position Stability	
At 20°C to 30°C	0.16 mm (or less)/hour.
At 10°C to 50°C	Within 1.6 mm/hour from the 25°C position.
Settling Time (To Within 1 Spot Diameter of Final Position)	3.5 $\mu\text{s}/\text{cm}$ + 5 μs .
CRT	
Type	Magnetic deflection.
Phosphor	Storage (similar to P1).
Quality Area	25% incrementally storable.
Horizontal	21 cm (8.250 inches).
Vertical	16.2 cm (6.375 inches).
Line Straightness (Deviation from Mean Straight Line)	0.5% or less of line length.
Stored Resolution	4000 clearly legible characters with good spacing, based upon a 90 X 70 mil matrix.
Horizontal	Equivalent to 400 line pairs (closely spaced line pairs exceed 25% incremental storage). Tested using a 400 X 287 dot matrix.
Vertical	Equivalent to 287 line pairs (closely spaced line pairs exceed 25% incremental storage). Tested using 400 X 287 dot matrix.
Display	
Dot Writing Time (Stored)	5 μs or less.
Line Writing Time (Stored)	At least 25 cm/ms at specified resolution.
Linearity	
Full Scale	Within 1% (spot will be within 1% of proper position for voltage applied) along the center screen axes.
Incremental	No more than 10% difference between any two cm.

Parameter	Performance Limits
Viewing Time	15 minutes or less recommended for specified resolution. Viewing time may be extended to one hour without permanent damage to the storage target. If a residual image is retained after long viewing times, the target may be returned to normal condition by successive erasures.
Drop Out	In a 287 X 400 dot display, no more than 5 stored dots in any 10 X 10 dot group will fade out to less than three raised collector dots.
Fade Up	In a 287 X 400 dot display, no more than 15 stored dots of any 10 X 10 group may band to an adjacent dot.
Hold Mode Time	The hold mode feature extends by a factor of 5 the time a display may be stored for later viewing.
Erase Time	500 ms or less.
View Mode Timer Interval	Stays in view mode 60 to 90 seconds after VIEW switch is pushed.

T4005 SYSTEM POWER SUPPLY

Parameter	Performance Limits	
Line Voltage Ranges	115 VAC	230 VAC
	Low	90 V to 110 V 180 V to 220 V
	Medium	104 V to 126 V 208 V to 252 V
	High	112 V to 136 V 224 V to 272 V
Line Frequency Range	48 to 66 Hz.	
Maximum Power Consumption at 115 VAC, 60 Hz		
Total (T4005)	350 W, 3.5 A.	
Less Display Device (4201)	81 W, 0.9 A.	
Fuse Data (Less Display Device)		
115 V	2 A fast.	
230 V	1.5 A fast.	
Temperature		
Operating Range	+10°C to +40°C (at sea level)	
Storage Range	-40°C to +65°C	
Thermal Cutout	Above 50°C	

Parameter	Performance Limits
Altitude	
Operating Range	To 15,000 feet (+20°C to +30°C)
Storage Range	To 50,000 feet

GLOSSARY OF SPECIAL TERMS

Computer Plot	The entire plot generated by a sequence of commands from the computer; e.g., commands to move and display dots (CRT plotter), or to incrementally move the pen (mechanical plotter).
Computer Interface	1) Computer Termination (specified by computer manufacturer) <ul style="list-style-type: none"> a) Cable & Connector(s) b) Line Drivers c) Line Receivers 2) Coding and Buffer (signal conditioning necessary for GDC) <ul style="list-style-type: none"> a) Level Shifters b) Function & Timing decoding and encoding
Display	What is actually displayed on the CRT, not necessarily equivalent to the Computer Plot.
Display Axes	The X and Y coordinate axes of the Display. The lower left hand corner is considered to be 0, 0 on the Display. An axis may be made up of 256, 512, or 1024 dots.
Display Scale	Commands/axis = the number of computer incremental commands required for full displacement along a display axis; e.g., 8 K means that it takes 8,192 computer commands to move along the entire length of a display axis, even though the display itself may have fewer dots (e.g., 512 or 1024) because of resolution limits of the CRT.
Display Offset	X, Y positioning of the Display 0, 0 with respect to the Computer Plot 0, 0. Offset range has 255 discrete steps (each step is equivalent to 32 computer commands, 1/256th of the GDC range). Therefore, the offset can range over 8,160 points (= 255 X 32).

Zero	The Display Offset is made 0, 0; therefore, the Display 0, 0 coincides with the Computer Plot 0, 0.	D/A Register	Up-Down counter which is connected to the D/A converter according to the Display Scale selected.
Initialize	Scale is set to internally selected value (e.g., 4 K), Offset is zeroed, Interrupt requests are reset and GDC is placed in the Ready Mode.	Offset Register	Up-Down counter used to store amount of offset. Used in conjunction with the offset switches.
Ready	The operating mode of the GDC. It is ready to accept and display a Computer Plot.	Display Scale Register	Set of latches that hold the information as to Scale (8K, 4K, etc.) and Aspect Ratio (1:1, 1:1/2, etc.) for that particular display.
Frame	The setup mode of the GDC. Scale and Offset controls may be manipulated and the write-through Frame Generator is operating. The write-through Frame Generator overlays (but does not store) on the previous storage Display. The Frame's size and position indicate the presently selected values of Scale and Offset by circumscribing the plotted area on the stored display that will fill the next display if the same computer plot is re-executed.	Offset/Scale—Hold	Currently selected values of Offset and Scale are set into Display Parameter Hold Registers.
		Offset/Scale—Recall	Offset and Scale values held in the Display Parameter Hold Registers are loaded into the D/A Register and Display Scale Register.
		Erase	Erase pulse sent to Storage CRT.
Saveplot	Feature that allows the saving and replotting of a single computer plot.	Erase Inhibit	Erase pulses blocked from going to Storage CRT.
		Frame Origin Direction Indicators	Indicate that the Frame origin (0, 0) is off the Display area. There is a light for each direction; up, down, left, right.
		Offset Zero Indicator	Indicates that Offset is 0, 0.
Begin	Computer software initiated to save away (in core, on disk or tape, etc.) a forthcoming computer plot.	Offset Switches Not True Indicator	Indicates that the Offset switches do not reflect the actual Offset present in the up/down counter register, e.g. zero, Initialize and Offset/Scale—Recall forces the Offset to certain values irrespective of Offset switch positions.
Finish	Computer software initiated to stop saving plotting information and to also finalize word counts and addresses for subsequent retrieval of the saved plot.	Frame Too Large Indicator	Indicates that the Scale selected is 4X larger (or more) than the Scale of the current Display; hence, the Frame can easily surround the display and thus never be seen.
Replot	Recalls a saved plot from core, disk, etc. and displays it using the current values of Scale and Offset.		
Multiple Saveplot	Feature that allows saving and replotting of multiple computer plots. The plots are addressed by number for saving and recalling.		
Plot Number Indicators	Indicate the numbers of the plots that have been saved since the last Plot Number Reset.	Zoom	That feature which allows Scale and Offset selection to be represented on any Display by an appropriately scaled and positioned frame.

Specification—T4005/4201

Modified Aspect Indicator	Indicates that the display was plotted with an aspect ratio other than one to one.	Computer Camera Film Advance	Computer controls film advance.
Computer Zero	Computer sets GDC to Zero.	Computer CRT Selection	Computer controls which of several concurrently operating display devices is to be used.
Computer Scale	Computer Selects Scale.	Frame Blanked Indicator	Indicates that Frame has been blanked out and will not appear on screen.
Computer Recall	Computer recalls Offset/Scale values held in Display Parameter Hold Register.	Local	Computer Plot is sent to GDC.
Computer Erase	Computer erases CRT.	Remote	Computer Plot is sent to External equipment other than GDC system.
Computer Storage Control	Computer selects Store/Non-Store Mode.	Computer Run Indicator	Computer is operating; i.e., is not in the WAIT mode.
Computer Mode Control	Computer selects mode of GDC operation.	L.S.B.	Least Significant Bit.
Computer Camera Shutter	Computer controls camera shutter.	M.S.B	Most Significant Bit.

APPENDIX A

T4005 TTL SPECIFICATIONS LEVELS

INPUTS

Logical 1

An input line will recognize a logical 1 with an input voltage level of 2.0 V to 5.5 V (maximum allowable positive input).

For noise margin, the worst-case logical 1 **input** voltage will be a worst-case logical 1 **output** voltage of 2.4 V.

Logical 0

An input line will recognize a logical 0 with an input voltage level of 0.8 V to 0 V (ground).

For noise margin, the worst-case logical 0 **input** level will be a worst-case logical 0 **output** level of 0.4 V.

OUTPUTS

Logical 1

An output line will be at the logical 1 level when the output voltage is 2.4 V to 5.5 V.

Logical 0

An output line will be at the logical 0 level when the output voltage is 0.4 V to 0 V (ground).

CURRENT LOADING

INPUTS

Input **lines** are specified as to the sum of normalized load factors each line must drive. Most 74N Series IC's have a normalized input load factor of 1.0 for each input of multiple-emitter transistors. (Some flip-flop IC's have normalized input load factors greater than 1.0. Refer to the design loading charts for specific devices.)

Logical 1

For a normalized input load factor of 1.0, at a logical 1 input level of 2.4 V, each input sinks 40 μ A or less. With the input voltage at the maximum allowable level of 5.5 V, the inputs sink 1 mA or less.

Logical 0

For a normalized input load factor of 1.0, at a logical 0 input level of 0.4 V, each input sources 1.6 mA or less.

OUTPUTS

Output **lines** are specified as to their fan-out capability. Fan-out is the ability of a 74N Series IC device to drive a given number of normalized input loads.

Logical 1

At a logical 1 output voltage, an output line will source current into a specified number of normalized loads.

Logical 0

At a logical 0 output voltage, an output line will sink current from a specified number of normalized loads.

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SECTION 2

CIRCUIT DESCRIPTION

BLOCK DIAGRAM DESCRIPTION

General

The following discussions are provided to aid in understanding the overall concepts of the T4005/4201. A basic block diagram of the T4005 is shown in the Diagrams Section. The flow of information throughout the T4005 is conceptually shown in the basic block diagram in which the broad lines indicate digital data flow, the thin lines indicate analog data flow, and the dashed lines indicate control signals. Each block represents a major circuit function within the instrument. The number(s) in each block refers to the card(s) on which the circuits are found. Complete schematics for the cards are located at the rear of this manual.

Block Diagram

X or Y increments, delivered from the computer (via an interface) or from the Frame and Locate Positioning circuits are first applied to the X or Y Up/Down Count Control circuit. The Up/Down Count Control circuit sets the Main Position Register to count either up or down on plus or minus increments respectively. The pulses then increment or decrement the Main Register appropriately. In the READY Mode, the Up/Down Count Control receives the X and Y pulses from the computer. In the FRAME or LOCATE Mode, the pulses emanate from the control panel OFFSET pushbuttons which activate the Frame and Locate Positioning circuits.

In the FRAME Mode there is a transfer of information from the Main Position Registers to the Offset Registers. As the Main Register is incremented to move the Frame around, the Offset Registers are also incremented so that the present position of the lower left-hand corner of the Frame in relation to the absolute origin (0,0 of the 8K X 8K matrix) is dynamically maintained. Now when the GDC is returned to READY, the contents of the Offset Registers are complemented and loaded into the Main Registers so that upon replotting, that portion of the previous display which appeared inside the Frame will appear full-screen and in the proper registration. The Frame offset as well as the Display Scale used may be retained for future use by pressing the front-panel OFFSET/SCALE RETAIN button. The Frame location and scale size may then be recalled from memory when needed, by pressing the OFFSET/SCALE RECALL button.

The outputs (Bit 0 through Bit 12) of the X and Y Main Position Registers are applied thru the X and Y Axis Scaling

Switches to 10 Bit digital to analog converters. The Scaling Switches essentially allow the D/A converters to slide along the Main Position Registers. The D/A converter MSB (most significant bit) is aligned with the Main Register MSB in the 8K Display Scale, and moves down 5 bit positions as the Display Scale is scaled down to 256. The higher order bits of the Main Register not used by the D/A converter detect on-screen or off-screen position, and thus are used to control the Z-Axis Logic.

The X and Y D/A converters take the digital input from the Scaling Switches and convert it to the appropriate analog voltage for use by the Display Driver Cards. In the FRAME and LOCATE Modes, the output of the Frame/Locator Generator is summed with the output of the D/A Converter.

The size of the Frame produced by the Frame/Locator Generator is determined by the relationship between the last display scale, at which the current display was plotted, and the current display scale selected. If these two display scale sizes are the same, the Frame is full-screen; if the current display scale is half of the last display scale, then the Frame is one-half size, etc. The magnitudes of the analog voltages making up the Frame, and hence its size, are determined by the Frame Size Decoder, which compares the inputs from the X and Y Last Scale Registers and X and Y Current Scale Registers, to set the maximum excursion of the integrator circuit in the Frame/Locator Generator. The size of the Locator in the LOCATE Mode is always one-eighth screen. In the FRAME or LOCATE Mode, the Frame/Locator Generator also produces a Write-Thru Z-Axis signal for use by the Display Driver Cards.

The Display Driver Cards receive the X and Y analog signals from the D/A Converters and the Z-Axis beam control signal from the Z-Axis Logic circuit on X,Y,Z busses. These cards provide the X and Y drive and the necessary control signals to put up a display on the selected Display Device(s).

Various front-panel control functions may be forced by the computer as shown on the Block Diagram.

The primary power supply for the slightly modified Type 611 Display Unit (part of the T4005 package) is interlocked with the GDC primary supply. The Line Selector Blocks on the GDC and the Display Unit must be set to the

same primary voltage (i.e., both set to 115 VAC or both to 230 VAC) for power to be supplied to the Display Unit. The GDC and the Display Unit each have their own power ON-OFF switches.

Ready Mode Block Diagram

The $\pm X$ and $\pm Y$ increments (delivered from the computer through an interface) are applied to the Up/Down Count Control circuit. The Up/Down Count Control circuit sets the Main Position Register to count either up or down, on plus or minus increments respectively. The pulses from the computer then increment or decrement the Main Register. The X and Y Augment circuitry provide additional dots (in the 512 and 256 Display Scales) to improve the clarity of the trace at higher magnification.

A skip command from the computer will inhibit the normal input and increment bit Q8 of the Main Register (Main Register bits 1 through 13 are designated as Q0 through Q12 on the Mode Block Diagrams). This causes the dot to move (without writing) an equivalent of 256 counts in the direction dictated by the Up/Down Count Control.

The outputs of the X and Y Main Position Registers are applied, through the Display Scaling circuit, to the 10 bit Digital to Analog Converters. The outputs of the D/A Converters are analog signals (X and Y) which are applied to the Display Driver Cards.

Bits Q8 through Q12 of the Main Register are applied to the Sector Detector circuit which detects an in sector or out of sector display. A sector is that area of the plot contained within the framing window. The logical output of the Sector Detector circuit is used to control Z axis logic to inhibit the beam when the plot is out of sector.

Frame Mode Block Diagram

The X and Y circuits for Frame positioning are identical, and only one axis will be explained.

The $\pm X$ position increments, from the Frame Positioning circuit, are applied to the Up/Down Count Control which sets the Main Position Register to count either up or down, depending upon the position button pushed. The position pulses then increase or decrease the contents of the Main Register appropriately.

The position pulses are also applied to the Offset Register via the Offset Steering network. These pulses increment the Offset Register so that the register always contains the present position of the lower left corner of the frame relative to the absolute origin (0, 0 of an 8 K by 8 K matrix). The Last Plot Display Scale circuitry controls the Offset Steering circuit, so that the Offset Register receives the proper number of increments as the Frame is repositioned on the plot. Offset information in the Offset Register is transferred to the Main Register upon returning to the Ready Mode.

The Frame Size Decoder compares outputs of the Present Display Scale and the Last Plot Display Scale circuits, to set the proper frame size to the on-screen display. After a display has been plotted, the Last Plot Display Scale and the Present Display Scales are equal. If the Frame Mode is now selected, the Frame Mode Decoder sets the Frame Generator to produce frame size 1 (one). The Frame size therefore equals the display format. The Last Plot Display Scale does not change in the Frame Mode, therefore, if a different Display Scale is selected (while still in the Frame Mode) the displayed frame size will change. Assume that a plot is made with the 1 K Display Scale selected, and the Frame Mode is then selected. Both the Last Plot and the Present Display Scales are now 1 K, and a size 1 (one) Frame is displayed. Now if the 512 Display Scale is selected, the Present Display Scale changes to 512, while the Last Plot Display Scale remains at 1 K. A 2 to 1 ratio exists between the Last Plot and Present Display Scales, and a frame size of 1/2 is selected. Selecting the 256 Display Scale results in the Frame Generator producing a frame that is 1/4 the size of the display format. The previous frame will not be visible, because the display unit changes from the stored to the write-through mode when the T4005 Frame Mode is selected.

In the Frame mode, the 10 bits of the D/A Converter are connected through the Display Scaling circuit to the low order 10 bits (Q0 through Q9) of the Main Position Register. Bits Q8 through Q12 of the Main Register and Overflow detector bits Q13 and Q14 are used in conjunction with the Off-screen Frame Detector to inhibit the Frame when the Frame origin is out of framing limits. They also turn on the Frame direction light to indicate the direction the frame origin left the screen.

When Frame Mode and Home are selected simultaneously, the following events occur: a count of 512 is preset in the "X" Main Register, the gain of the amplifier at the output of the D/A converter is doubled, and causes the "X" deflection input voltage of the display device to be set to zero volts. Setting the deflection input voltage to zero

volts insures the origin of the frame is at the Home position; the count of 512 in the Main Register allows the origin of the frame to either be positioned left or right from the Home position. Doubling the gain of the amplifier allows the frame origin to be positioned the full screen distance by a count of 512 instead of 1024 which is required for the other modes.

Frame positioning on screen is limited to a certain number of addressable points. The number of addressable points, during Frame positioning depends upon the display scale used; 8 K - 512 positions, 4 K - 256 positions, 2 K - 128 positions, etc. The Frame Step Scaling circuit, controlled by the Last Plot Display Scale, disconnects the low order bits of the Main Position Register from the D/A Converter progressively as smaller display scales are selected. This restricts on screen Frame positioning to only those unique positions addressable by the framing circuit.

The analog output of the D/A Converter is summed with the output of the Frame Generator to provide the X-axis signal to the Display Driver Cards.

Locate Mode Block Diagram

In the Locate Mode, an "L" shaped write-through cursor is displayed. The Offset button provides a means of positioning the Locate cursor anywhere on screen. The lower left corner of the cursor corresponds to the plot origin (0, 0). The plot origin can be repositioned on all display scales.

In 8 K, the ten most significant bits of the Main Position Register are connected to the D/A Converter via the Display Scaling circuitry. To maintain a 1 to 1 correspondence with the located screen position and the Main Position Register contents, the Locator increment is always steered to the bit position of the Main Register that is connected to the LSB of the D/A Converter. The Locator increment is steered to the proper Main Register bit through the Locator Steer-Ahead circuitry. The LSB of the D/A Converter is connected to this same Main Register bit via the Display Scaling circuitry.

For example, in 8 K Display Scale, bit Q3 of the Main Position Register is connected to the LSB of the D/A Converter, and the Locator positioning count is fed to bit Q3. With the 4 K Display Scale selected, bit Q2 is connected to the LSB of the D/A Converter and Q2 counts. In 1 K, 512, and 256 Display Scales, bit Q0 of the Main Position Register is always connected to the D/A LSB; therefore, the Locator positioning count is always delivered to Q0. The Main Positioning Register bits which are less significant

than the bit connected to the D/A Converter are held zero-set during Locator positioning.

The positioning of the Locator is limited to on-screen coordinates; thus, the Locator Screen Limit circuit detects either Locator Zero position or Locator full-screen position. Therefore, at either of these two extremes a position inhibit signal is fed back to the Up/Down count control. This stops further positioning of the Locator in the off-screen direction.

The Locator Generator output and the D/A output are summed at the input of the Accessory Driver Amplifier.

DETAILED CIRCUIT DESCRIPTION

Card GC-1

Mode Control

A Function Reset or an Initial + P.O. Reset will LO pulse the Reset line to preset U6A and U6B. This turns on Q8 and Q18 to light the Vertical and Horizontal AUGMENT lamps, and sends a X and Y Aug Sense bit to the GDC Status Word. The lamps may also be lighted, and the X and Y Aug Sense bit raised to a logical one by pressing the front-panel AUGMENT buttons to clock U6A and U6B. The Vertical and/or Horizontal Augment may be turned off by a computer command (Y CPU Aug Off and X CPU Aug Off), which clears U6A and/or U6B.

In the READY Mode, U16D pin 12 and U16C pin 9 are held LO by the Ready latch (U80A-U80B). Now, if U6B pin 10 and/or U6A pin 14 are LO, X and/or Y Aug signals will be sent to the Position Registers.

Power On Reset, Initial Switch, and Software Initial are ORed together. Activating any one of these will reset various latches and Registers throughout the GDC.

Pressing the front-panel FAST Switch will trigger U26A to turn on the FAST lamp and drop out relay K38 to increase the repetition rate of the Offset Oscillator U38, allowing the Frame to be moved rapidly on the display. With a 256 or 512 Scale selected, Q44 is turned on to decrease the repetition rate of U38.

The Software Light Strobe output is activated by a CPU Reset, a CPU Select Lights or an Initial or Power On Reset.

The Auto Erase light and Status Word Bit are activated by the front-panel AUTO Switch or by a CPU Auto Set command. With Auto Erase selected, an erase may be initiated by any of the four inputs to U64A (Write T4, H Switch if strapped, Conditional CPU Erase, or RECALL Switch) or by the MANUAL erase switch or Unconditional CPU Erase inputs to U66A.

The Ready Latch (U80A-U80B) is set by the READY Switch or CPU Ready input. This also resets the Locate Latch (U96A-U96B). An Initial or Power On Reset always places the GDC in the Ready Mode.

Pressing the LOCATE Switch or a CPU Locator LO input to U88B will set the Locate Latch and reset both the Ready and Frame Latches.

The Frame Latch (U98A-U98B) is set by the FRAME Switch or the CPU Frame input. If switching from LOCATE to FRAME, U34 must time out before the Frame signal is gated through to the Latch. Selecting the Frame Mode also resets the Ready and Locate Latches.

Pressing the HOME Switch or changing Display Scales will gate a HI to the output of U64B. If the Locate Latch is set, U42C pin 8 goes LO to send a Clear signal to the Offset Register and Loader (Card GC-4).

CARD GC-1

D/A Converter Reference System (X)

The 10 Bits from the Scale and Sector D/A Switch (CG-2) are applied to U110 and U130 (the Digital to Analog converters). The five high order Bits applied to U110 select one of thirty-two possible analog levels. The five low order Bits applied to U130 perform the same function. The current source for U130 (U136-Q138) is adjustable for calibration purposes. The outputs of U110 and U130 are applied to summing amplifier U104, to provide the X-Axis output to the Display Driver Card.

The X Frame Locator Drive is an analog input to the summing amplifier used to move the Frame or Locator about the Display Unit X-Axis. The magnitude of the analog steps is determined by the DISPLAY SCALE selected (8k, 4k, etc.). Relays K102 and K104 compensate for the difference in the steps required for full screen movement of the Frame and Locator (512 for Frame and 1024 for Locator).

The X D/A Output level for the X-Axis origin (zero point) is 2.5 volts. This level is present when all 10 bits from the D/A Switch are LO (zero).

CARD GC-2

Display Scale (X)

The display scale may be selected by the front-panel DISPLAY SCALE pushbuttons, or by the computer. Only one scale may be selected at any one time. The display scale selected is indicated on the front panel by turning on the appropriate scale lamp.

The input from the computer or pushbutton is applied to the present scale latch (cross-coupled gates) to set the latch for the scale selected. For example; pressing the 8K pushbutton sets the output of U4H HI to turn on Q12, lighting the 8K lamp. The HI output of U4B is cross-coupled to the input of U6A to set its output to the LO state. This LO applied to the input of U4B latches the circuit.

The present selected scale may be retained for future use by pressing the RETAIN pushbutton. With the 8K scale selected, pressing the RETAIN button will clock the HI from U4B to the output of U10A. U10A will remain in this condition (output HI) as other display scales are selected. The display may be returned to the retained scale by pressing the RECALL pushbutton. This gates the HI from U10A through U8D (NAND gate) to place a LO on the input of U4B, setting the 8K present scale latch as described above.

The DISPLAY SCALE may be preset to initialize to any of the six scales by placing a strap from the collector of Q40 to the appropriate scale input. Then, when the INITIAL button is pressed or the T4005 is powered down and back up, Q40 will turn on to set the selected scale latch.

The circuit consisting of U42B, U42C, U42D, U44A, U44B, U44D, U2B, U2C, U8A, U30C, U30D, and U46A is used to clear the present scale latches and certain registers when switching from one display scale to another.

U48A, U48B, U48C sample the output of the present scale latches to set up a 3 Bit code to inform the computer of the display scale selected.

MSB and Direction Light (X)

This portion of Card GC-2 is used to detect the X MSB (most significant bit) for sector control of the Z-Axis. It also provides direction light logic for the Left and Right Offset lights.

In the READY or LOCATE Mode, with the 8K scale selected, the output of U102C goes LO to disable all five of the NAND gates (U112, U114, U116A, U116B, U46C). This means that the writing beam is unblanked, regardless of the value of the high order bits (Bits 8 through 12) from the Position Register. With the 4K scale selected, the top four NAND gates are disabled, but if Position Register Bit 12 is HI (1), U46C output goes LO. This LO applied to the negative input OR gate (U118) sends its output HI to turn off (blank) the writing beam. The remaining DISPLAY SCALE selections may be traced out in a similar manner.

With the FRAME Mode selected, the circuit above is latched in the 1K scale by U108B; and Position Register Bits 10, 11, and 12 must be LO (0) to turn on the writing beam. The output from U108B is passed through inverter U46D to the D/A Switch to latch it in the 1K scale. Position Register Bit 14 is used to turn off the beam when the Frame is not in sector.

The offset lights are also used to indicate an ambiguous situation. For example, a plot is put up in the Frame Mode and 256 scale, then the operator switches to the 8K scale. This makes the Frame 32 times larger than the display. In this case, both the left and right offset lights turn on to indicate this condition. The Frame Size input to U44C is LO, Bit 14 is LO to indicate out of sector, and the Offset Light Enable input is HI. These three input conditions will turn on both lights.

Bit 13 is used to prevent wrap-around of the display from appearing on-screen. When the display goes off-screen in either direction Bit 13 will change states. A HI to LO transition of either Bit 13 or Bit 14 will low-pulse the input of U118 to blank the display.

D/A Switch (X)

The Digital to Analog switch is the electronic equivalent of a 10 pole 6 throw switch. It is used to select which bits on the Position Register are sent to the D/A Converter. The D/A switch is shifted by the Display Scale input. For example, with the 1K scale selected (see Fig. 2-1), the D/A switch samples Position Register bits Q0 through Q9 or with the 256 scale selected the D/A switch samples bits Q0 through Q7 plus Q0 AUG and Q1 AUG.

Frame Size (X)

The two inputs to this circuit are the Last Place Scale Latch and the Present Scale selection. The output goes to the Frame Generator to determine the size of the Frame. Also, one output line ($> 2:1$) goes to the MSB and Direction Light circuit as described previously.

Example 1: With the Last Place Latch set to 1K and Present Scale 512 selected, the output of U94D goes LO to select 1/2:1 for Frame size.

Example 2: With the Last Place Latch set to 1K and Present Scale 2K selected, the output of U86A goes LO to select 2:1 for Frame size.

Example 3: With the Last Place Latch set to 256 and Present Scale 8K, 4K, 2K, or 1K selected, the output of U80 goes LO to indicate a Frame size greater than 2:1 (up to 32:1 with 8K scale selected). To indicate that this is an impractical situation, the output of $> 2:1$ is sent to the MSB and Direction Light circuit to turn on both the Left and Right OFFSET direction lights.

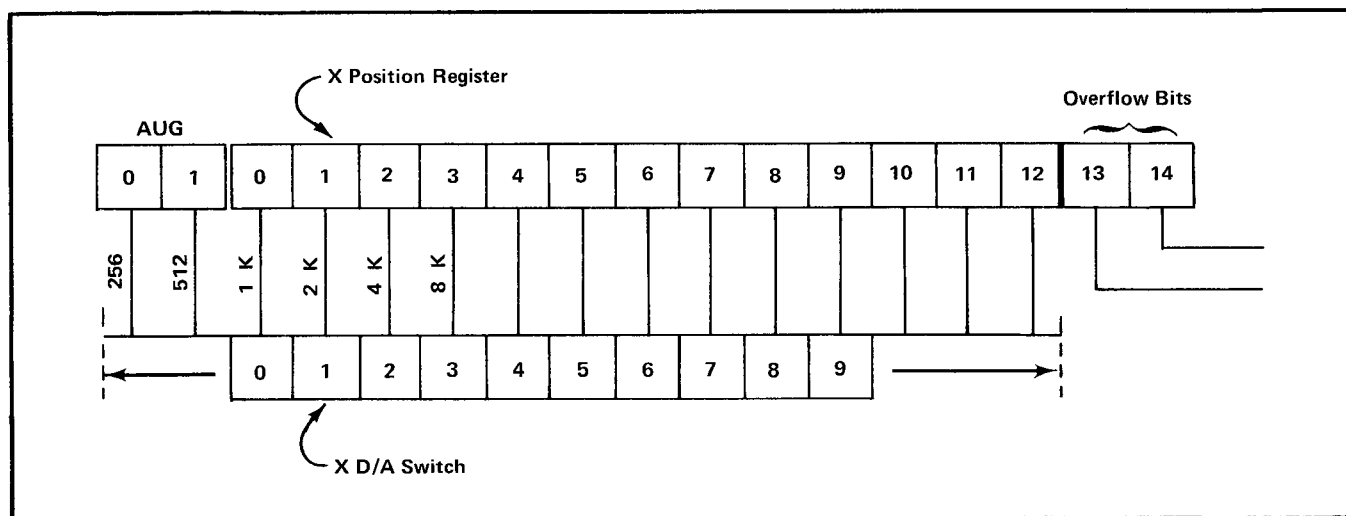


Fig. 2-1. D/A Switch position with 1 K scale selected.

Home and Locator Limit (X)

The 10 bits from the D/A Switch are sampled by NAND gate U134 to determine when the Frame is in the Home position, or the Locator is at the Origin.

Selecting the FRAME Mode sets D/A Switch output Bit 9 to the LO (0) state and the other 9 bits (Bits 0 through 8) will be HI (1) if the Position Register has been incremented to Home. For example, assume that the FRAME Mode has been selected, the HOME button pressed, and the Position Register has not been cleared. Selecting the FRAME Mode sets the Frame input HI, the Position Register high order Bit(s) sets the MSB input LO, and pressing the HOME button turns on the Inc Home Osc. Now, every time the Inc Home Osc goes HI the output of U126C (Inc Home) will be low-pulsed to clock the Position Register. This continues until the Position Registers have been incremented to Home or Origin, at which time the front-panel HOME light will turn on (providing the Y-Axis Position Register has also been incremented to Home or Origin).

In LOCATE Mode, the 10 bits from the D/A Switch are sampled by U134 and U136 to prevent the Locator from being incremented off-screen.

CARD GC-6

Display Scale (Y)

The display scale may be selected by the front-panel DISPLAY SCALE pushbuttons, or by the computer. Only one scale may be selected at any one time. The display scale selected is indicated on the front panel by turning on the appropriate scale lamp.

The input from the computer or pushbutton is applied to the present scale latch (cross-coupled gates) to set the latch for the scale selected. For example, pressing the 8K pushbutton sets the output of U4B HI to turn on Q12, lighting the 8K lamp. The HI output of U4B is cross-coupled to the input of U6A to set its output to the LO state. This LO, applied to the input of U4B, latches the circuit.

The present selected scale may be retained for future use by pressing the RETAIN pushbutton. With the 8K scale selected, pressing the RETAIN button will clock the HI from U4B to the output of U10A. U10A will remain in this condition (output HI) as other display scales are selected. The display may be returned to the retained scale by pressing the RECALL pushbutton. This gates the HI from U10A through U8B (NAND gate), to place a LO on the input of U4B, setting the 8K present scale latch as described above.

The DISPLAY SCALE may be preset to initialize any of the six scales by placing a strap from the collector of Q40 to the appropriate scale input. Then, when the INITIAL button is pressed or the T4005 is powered down and back up, Q40 will turn on to set the selected scale latch.

The circuit consisting of U42B, U42C, U42D, U44A, U44B, U44D, U2B, U2C, U8a, U30C, U30D and U46A is used to clear the present scale latches and certain registers when switching from one display scale to another.

U48A, U48B, U48C sample the output of the present scale latches to set up a 3 Bit code to inform the computer of the display scale selected.

MSB and Direction Light (Y)

This portion of Card GC-6 is used to detect the Y MSB (most significant bit) for sector control of the Z-Axis. It also provides direction light logic for the Left and Right OFFSET lights.

In the READY or LOCATE Mode, with the 8K scale selected, the output of U102C goes LO to disable all five of the NAND gates (U112, U114, U116A, U116B, U46C). This means that the writing beam is unblanked regardless of the value of the high order bits (Bits 8 through 12) from the Position Register. With the 4K scale selected, the top four NAND gates are disabled but if Position Register Bit 12 is HI (1) U46C output goes LO. This LO, applied to the negative input OR gate (U118), sends its output HI to turn off (blank) the writing beam. The remaining DISPLAY SCALE selections may be traced out in a similar manner.

With the FRAME Mode selected, the circuit above is latched in the 1K scale by U108B; and Position Register Bits 10, 11, and 12 must be LO (0) to turn on the writing beam. The output from U108B is passed through inverter U46D to the D/A Switch to latch it in the 1K scale. Position Register Bit 14 is used to turn off the beam when the Frame is not in sector.

The offset lights are also used to indicate an ambiguous situation. For example, a plot is put up in the Frame Mode and 256 scale, then the operator switches to the 8K scale. This makes the Frame 32 times larger than the display. In this case, both the left and right offset lights turn on to indicate this condition. The Frame Size input to U44C is LO, Bit 14 is LO to indicate out of sector, and the Offset Light Enable input is HI. These three input conditions will turn on both lights.

Bit 13 is used to prevent wrap-around of the display from appearing on-screen. When the display goes off-screen

in either direction Bit 13 will change states. A HI to LO transition of either Bit 13 or Bit 13 will low-pulse the input of U118 to blank the display.

D/A Switch (Y)

The Digital to Analog switch is the electronic equivalent of a 10 pole 6 throw switch. It is used to select which bits on the Position Register are sent to the D/A Converter. The D/A switch is shifted by the Display Scale input. For example; with the 1K scale selected (see Fig. 2-2), the D/A switch samples Position Register bits Q0 through Q9 or with the 256 scale selected the D/A switch samples bits Q0 through Q7 plus Q0 AUG and Q1 AUG.

Frame Size (Y)

The two inputs to this circuit are the Last Place Scale Latch and the Present Scale selection. The output goes to the Frame Generator to determine the size of the Frame. Also, one output line ($> 2:1$) goes to the MSB and Direction Light circuit as described previously.

Example 1: With the Last Place Latch set to 1K and Present Scale 512 selected, the output of U94D goes LO to select 1/2:1 for Frame size.

Example 2: With the Last Place Latch set to 1K and Present Scale 2K selected, the output of U86A goes LO to select 2:1 for Frame size.

Example 3: With the Last Place Latch set to 256 and Present Scale 8K, 4K, 2K, or 1K selected, the output of U80 goes LO to indicate a Frame size greater than 2:1

(up to 32:1 with 8K scale selected). To indicate that this is an impractical situation, the output of $>2:1$ is sent to the MSB and Direction Light circuit to turn on both the Up and Down OFFSET direction lights.

Home and Locator Limit (Y)

The 10 bits from the D/A Switch are sampled by NAND gate U134 to determine when the Frame is in the Home position, or the Locator is at the Origin.

Selecting the FRAME Mode sets D/A Switch output Bit 9 to the LO (0) state and the other 9 bits (Bits 0 through 8) will be HI (1) if the Position Register has been incremented to Home. For example; assume that the FRAME Mode has been selected, the HOME button pressed, and the Position Register has not been cleared. Selecting the FRAME Mode sets the Frame input Hi, the Position Register high order Bit(s) sets the MSB input LO, and pressing the HOME button turns on the Inc Home Osc. Now, every time the Inc Home Osc goes Hi the output of U126C (Inc Home) will be low-pulsed to clock the Position Register. This continues until the Position Registers have been incremented to Home or Origin, at which time the front-panel HOME light will turn on (providing the X-Axis Position Register has also been incremented to Home or Origin).

In LOCATE Mode, the 10 bits from the D/A Switch are sampled by U134 and U136 to prevent the Locator from being incremented off-screen.

CARD GC-3

X Position Register

X and Y Last Plot Latch Strokes are generated each time the GDC receives an increment from the computer, and when an Initial or Power On Reset is made.

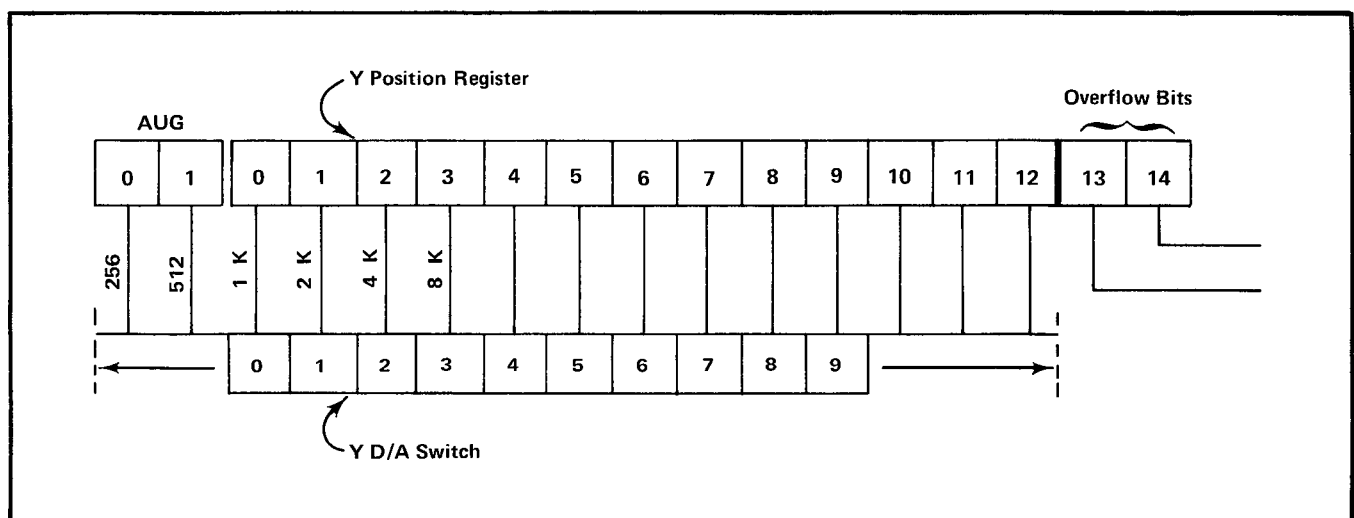


Fig. 2-2. D/A Switch position with 1 K scale selected.

Circuit Description—T4005/4201

In the READY Mode, the + and – Computer Increments are steered through U4A and U4D to toggle the Left/Right flip-flop (U10A-U10B), incrementing the Position Register, and through U10C to clock the Augment circuitry in the Offset Register and Loader.

In the FRAME and LOCATE Modes, the flip-flop (U10A-U10B) is toggled by the front-panel OFFSET direction control through gates U2A-U2B. In the LOCATE Mode, the Right Locator Stop and Left Locator Stop inputs to U6A-U6B prevent the display from being incremented off-screen. For example, if the display has been incremented to the extreme right of the display area, the Right Locator Stop input to U6A goes LO, locking out any more right increments from the OFFSET control.

The Inc Home input is used to increment the Offset and Position Registers to the Home position when the front-panel HOME button is pressed.

The Augment single-shot (U20) is used to fill in the space between written dots when the 256 or 512 Augment is selected. For example, with the 256 AUGMENT selected, a command write one dot (Inc input to U18A) will cause four dots to be written. This is accomplished by using the outputs of Registers U28A and U28B as inputs to the single-shot. U22B is the steering gate for 256 Augment, and U22C is the steering gate for 512 Augment. With any DISPLAY SCALE other than 256 or 512 selected, the dot increment is steered through U4B to the Position Register.

The RST input to the single-shot prevents retriggering during Register Settling Time. The X Augmenting output is used by the Z-Axis control to make up the Wait command to hold off the computer during Augment time. The X Inc or Add Inc output is used by the Z-Axis Write command circuitry.

Switching display scales activates the ▲ Display Scale Clear input to clear the Augment Registers. A HI on the Frame Transfer or Master Clear input will clear all Registers.

CARD GC-5

Y Position Register

X and Y Last Plot Latch Strokes are generated each time the GDC receives an increment from the computer, and when an Initial or Power On Reset is made.

In the READY Mode, the + and – Computer Increments are steered through U4A and U4D to toggle the Left/Right flip-flop (U10A-U10B), incrementing the Position Register

and through U10C to clock the Augment circuitry in the Offset Register and Loader.

In the FRAME and LOCATE Modes, the flip-flop (U10A-U10B) is toggled by the front-panel OFFSET direction control through gates U2A-U2B. In the LOCATE Mode, the up Locator Stop and Down Locator Stop inputs to U6A-U6B prevent the display from being incremented off-screen. For example, if the display has been incremented to the extreme top of the display area, the up Locator Stop input to U6A goes LO, locking out any more up increments from the OFFSET control.

The Inc Home input is used to increment the Offset and Position Registers to the Home position when the front-panel HOME button is pressed.

The Augment single-shot (U20) is used to fill in the space between written dots when the 256 or 512 Augment is selected. For example, with the 256 AUGMENT selected, a command to write one dot (Inc input to U18A) will cause four dots to be written. This is accomplished by using the output of Registers U28A and U28B as inputs to the single-shot. U22B is the steering gate for 256 Augment, and U22C is the steering gate for 512 Augment. With any DISPLAY SCALE other than 256 or 512 selected, the dot increment is steered through U4B to the Position Register.

The RST input to the single-shot prevents retriggering during Register Settling Time. The Y Augmenting output is used by the Z-Axis control to make up the Wait command to hold off the computer during Augment time. The Y Inc or Add Inc output is used by the Z-Axis Write command circuitry.

Switching display scales activates the ▲ Display Scale Clear input to clear the Augment Registers. A HI on the Frame Transfer or Master Clear input will clear all Registers.

CARD GC-3, 5

Position Register Bits 0 through 14

The 256 skip ahead command from the interface card is applied through inverter U2C to pin 8 of U42C. The Setting Up input to pin 9 is LO except when setting up, so the 256 skip ahead command is gated through U44A by the Inc Single-Shot (U46) to Position Register U94A (Bit 8 of the Position Register) to move the dot 256 increments in the direction indicated in the IOCC word.

For normal dot incrementing, the clock pulse applied to U26A pin 1 is inverted and used to trigger single-shot U46. The pin 8 output of U46 is steered through U44B and U18D to the X or Y Position Register normal input circuitry (U18A-U4B-U32C). The pin 6 output of U46 is used by the Offset Register and Loader (refer to Card GC-4 circuit description).

In the LOCATE Mode and 256, 512 or 1K scale, the dot is incremented through the normal input to Position Register Bit 0. The sliding D/A Switch is positioned by the DISPLAY SCALE selected so that in the 256 scale the two least significant bits of the D/A Switch hang off the end of the Position Register and are considered zero. Refer to Fig. 2-3 for the relationship between the Position Register and the D/A Switch Bits for the particular display scale selected. In the 1K scale, the Position Register Bit 0 is matched with the D/A Switch Bit 0.

The Locator Steer Ahead circuit (U22A-U52B-U52C) is used in the 2K, 4K, and 8K scales to steer the least significant bit of the Position Register into the least significant bit of the D/A Switch. For example, with the 8K scale selected D/A Switch Bit 0 is aligned with Position Register Bit 3 (refer to Fig. 2-3). The pulse from the Inc Single-Shot U46 is steered through U52C and U74A to increment Position Register Bit 3 (U72B). The Position Register lower order bits (Bits 0, 1, and 2) are not incremented, since gate U18D is closed. The DISPLAY SCALE selected information from the Last Plot Latches is also fed to the computer so that the output of the Position Register can be correctly assimilated.

In the FRAME Mode, the Scale Offset Steer (U60A, U60B, U60C, U60D, U54C and U54D) provides a counting circuit to increment the Offset Register in proportion to the DISPLAY SCALE selected. For example, with the 8K scale selected, each time the Position Register is incremented, the Offset Register will also be incremented through U60A-U62-U64B. However, with the Last Plot Latch set to 512, the Position Register must be incremented 16 times before an increment is gated through U54C-U62-U64B to increment the Offset Register. This is done to insure that the information placed in the Offset Register accurately represents the actual position of the Frame in relation to the maximum 8K field. Refer to Fig. 2-3 for the relationship of the 9 bit Offset Register to the Position Register.

The Frame Transfer input to U34B sets Position Register Bit 9 to the one state. This sets the voltage reference level in the D/A Converter Reference System to a halfway value with the Frame in the Home position. This allows the Frame to be moved off-screen in any direction without wrap-around.

Position Register overflow bits 13 and 14 are used for In Sector control in the FRAME Mode (Bit 13 is also used in the LOCATE Mode). Bit 13 and Bit 14 must both be LO for the Frame to appear on-screen. The Frame Transfer input to U42B and U42D sets both registers to the zero state when FRAME Mode is selected. In the READY or LOCATE Mode, Bit 14 is latched to the zero state by a HI on the Frame Mode input to U42B.

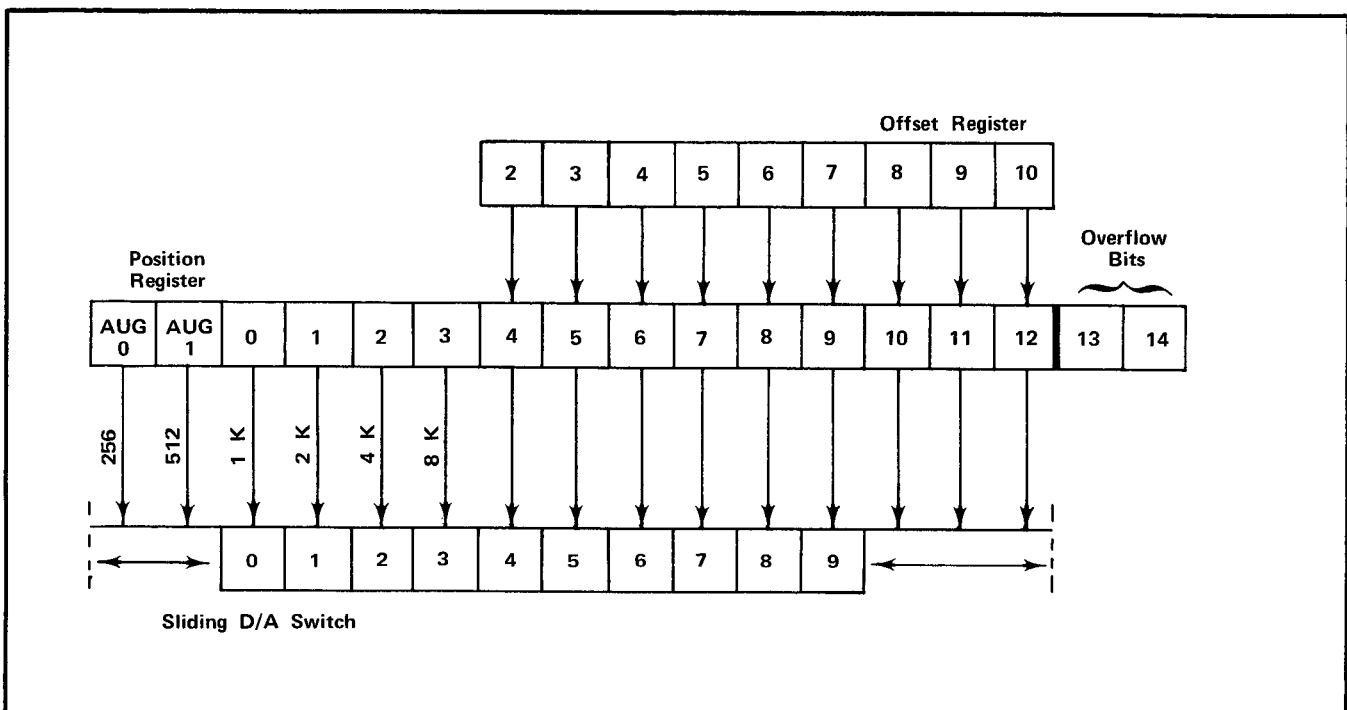


Fig. 2-3. The relationship of the Offset Register, Position Register and the sliding D/A Switch are shown in the drawing above (shown with 1 K DISPLAY SCALE selected).

For an Offset Transfer, when negatively transferring the contents of the Offset Register into the Position Register, the One Set Strobe is used to preset registers 0, Q1, Q2, and Q3 to the one state so the ADD +1 count can ripple through to register Q4.

CARD GC-4

Offset Register and Loader

When switching from FRAME to READY Mode, the contents of the Offset Register are negatively transferred to the Position Registers and a +1 count is added (complement and add method). Switching from FRAME to READY high-pulses the Offset Transfer input to U36. U36 pin 12 goes HI, and is inverted and applied to U20B, giving a Master Clear signal to clear the main Position Registers. At the same time, the pin 12 output of U36 is fed back to pin 10 to send pin 11 HI. The HI on pin 11 jam-transfers the contents of the Offset Registers into the Position Registers after they have been cleared.

Pressing the OFFSET RECALL button will high-pulse pin 2 of U36. This causes U36 output pins 4, 11, and 12 to go HI with the following results:

1. The Master Clear line is activated to clear the main Position Registers.
2. The outputs of U42A and B go LO to preset the Offset Registers.
3. The outputs of U2A and U4A go LO to transfer the contents of the Retain Latches into the Offset Registers.
4. The outputs of U40C and U40F go HI to transfer the contents of the Offset Registers to the main Position Registers.

If the following conditions are met, the augment circuitry will fill in the space between the last written dot and the present written dot in the 256 or 512 display scale.

INPUTS	LEVEL
Beam On	HI
In Sector	HI
X or Y Clock	LO
X or Y Inc	LO

If all of these conditions are met, the Aug Z and Aug Z Latched outputs will be HI. The Aux Write 0 input will

activate the Aug Z Latched output for a write without incrementing command. The Clear Aug input resets U44B.

The X Skip Inc or Y Skip Inc input sends a 256 skip ahead signal to the computer and turns on U14 to hold the Z-Axis off (Inc Dly) during the skip ahead. The R.S.T. (register settling time) output holds off the augment single-shot until the registers have had time to settle before allowing another increment.

The outputs of the Offset Registers are also sent to the Software area of the GDC for insertion in the Device Status Word.

CARD GC-7

D/A Converter Reference System (Y)

The 10 Bits from the Scale and Sector D/A Switch (GC-6) are applied to U90 and U10 (the Digital to Analog converters). The five high order Bits applied to U90 select one of thirty-two possible analog levels. The five low order Bits applied to U110 perform the same function. The current source for U110 (U116-Q118) is adjustable for calibration purposes. The outputs of U110 and U90 are applied to summing amplifier U84 to provide the Y-Axis output to the Display Driver Card.

The Y Frame Locator Drive is an analog input to the summing amplifier used to move the Frame or Locator about the Display Unit Y-Axis. The magnitude of the analog steps is determined by the DISPLAY SCALE selected (8K, 4K, etc.). Relay K80 compensates for the difference in the steps required for full screen movement of the Frame and Locator (512 for Frame and 1024 for Locator).

The Y D/A Output level for the Y-Axis origin (zero point) is 2.5 volts. This level is present when all 10 bits from the D/A Switch are LO (zero).

Z-Axis Control and D/A Converter

The X D/A Bit 0 or Y D/A Bit 0 changing from LO to HI or from HI to LO will send a Write command to the Display Controller. In the 256 or 512 scale, these bits do not change (unless AUGMENT is selected) so an alternate provision is made. With either the X or Y 256 or 512 scale selected, the output of U44C is latched LO. Now each time the X or Y position is incremented, a pulse is steered through U44B, U44D, U14A and U8C to flip-flop U56C-U56D, triggering U58 to low-pulse the Write line, sending a write command to the Display Controller.

To perform a write without incrementing (pen drop) function, the Bit 9, 10, and 11 Latched and the Aux Write

inputs must all be logical 0. This BCD input to U60 (BCD to Decimal converter) will produce a LO on Aux Write 0, and a HI on Aux Write 1 through Aux Write 7.

The X and Y MSB (most significant bit) inputs are used make up the In Sector command. If both X and Y MSB are LO, an In Sector command is generated. If either the X MSB or Y MSB input is HI, the In Sector output goes LO to indicate an out-of-sector condition.

The HOME light is turned on by Q62 when the X and Y MSB and the XO and YO (origin) input lines all are LO. This indicates that the Frame is at the origin or home position.

Inc Home Oscillator U64 may be triggered by the HOME Switch input, or the Home Osc input, in the Frame Mode.

A Wait command is sent to the computer when the R.S.T. input is LO or when Inc Dly (increment delay) is HI and either X or Y is augmenting (X or Y Augmenting LO).

Pressing the front-panel RETAIN Switch will turn off Q70 to clock the present scale Retain Latches on Cards GC-2 and GC-6. Q70 will also be turned off by a HI on the Reset Delay input line.

An Addressed command from the computer will turn on 0.5 second timer U2 to light the front-panel ADDRESSED lamp for 0.5 second.

CARD GC-7

Z-Axis Control and D/A Converter

The Set Up input is generated during a FRAME to READY Mode transition to hold off various GDC functions while the contents of the Offset Register are being jam-transferred into the Position Registers.

If any or all of the four Device selections are On, the output of U4B will be HI to turn off Q10, extinguishing the DISPLAY DEVICE OFF lamp. The output of U4B also inserts a Device On bit in the GDC Status Word (Card Acc-11). The output of U4B is Nanded with the Ready input in U6A to make up the Ready-Not Off signal to the computer.

The computer CPU Shift command sets U16A output HI to activate the appropriate circuitry on the Display Driver Cards Acc-5, -6, -7, and -8. The CPU Slant input drives the

output of U16B HI to set the Slant circuitry of the Display Driver Cards. A Function Reset or an Initial + P.O. Reset will reset the Shift and Slant flip-flops.

The Clock Interrupt circuitry is normally timed by a 60 hertz signal from the Power Supply. However, the 60 hertz input can be disabled and an external timing device connected. The computer Clock Disable input to flip-flop U20C-U24C sets the output of U20C LO to close timing pulse gate U24A. The computer Clock Enable pulse sets the flip-flop to the opposite state (U20C output HI) to allow timing pulses to be steered through U24A to the Clock Interrupt Request Latch U20B-U24B. When a timing pulse sets the latch (U20B output HI), it will stay in this condition until reset by a computer Clock Int Reset, or a P.O. + CPU Reset is applied to U24B.

The Frame Gen On input sets the Frame Generator Latch (U26C-U28C) for a HI on U26C output and a LO on U28C output. This sends a Frame Gen On signal to the GDC Status Gate (Card Acc-11) and a Frame + Locator Enable signal to the Frame Generator (Card GC-8). At the same time, the LO from U28C is RC coupled to the input of U28A to reset the Locator Generator Latch if it has been previously set.

The operation of the Locator Generator Latch (U26D-U28A) is similar to the Frame Generator Latch. The Locator Gen On input sets the outputs as follows: Locator Gen On—HI, Locator Enable — LO, and the Frame + Locator Enable — HI.

The Frame and Locator Generator Latches are reset by a Function Reset or an Initial + P.O. Reset.

When the GDC is switched from the READY Mode to either FRAME or LOCATE, the Ready Mode input goes LO to set the output of U28B HI.

CARD GC-8

Frame Generator

The Y Frame or Locator Drive amplifier (U55) is clamped, in the READY Mode, by Q33, Q37, CR57, and CR58 to prevent drift. It is also clamped between Frames to insure that each new Frame starts at the same voltage level. U55 is unclamped when the Frame + Locator Enable input goes HI. The HI turns off Q83, allowing free-running multivibrator Q84-Q87 to turn on. The LO pulse from the free-running multivibrator, applied to latch U20A-U20C, gates a LO to the base of Q33 to turn off the clamp circuit.

Circuit Description—T4005/4201

Voltage comparators U65 (lower limit) and U75 (upper limit) determine the maximum voltage swing of U55. The comparison voltage on pin 3 of U75 is determined by the DISPLAY SCALE selected. This in turn determines the size of the Frame. When the Y-Axis has reached its upper limit (voltage at pin 2 of U75 exceeds reference voltage on pin 3), the output pin 6 of U75 goes negative and is applied to U190B (X-axis latch) to unclamp X-axis amplifier U155. The output of U75 is also fed back to latch U22A-U22C. This turns off Q47, letting amplifier U55 hang until Q27 is turned on (when the X-axis has reached its upper limit) to run it back down.

The X Frame or Locator Drive circuitry is similar in operation to the Y Frame or Locator Drive circuitry.

In the LOCATE Mode, the Locator Enable input to U11A and U11C sets both the X and Y 1K relays (K13 and K113) to latch the Frame Generator to this scale. The Locator Enable input is also applied to U90D to blank the Z-Axis while the top and right sides of the Frame are running. This gives the "L" shaped Locator.

At each corner of the Frame, certain aberrations are produced. To prevent these aberrations from appearing on the display, U200B (a four input NAND gate) detects each corner and momentarily blanks the Z-Axis.

When FRAME or LOCATE Mode is selected, the Frame or Locator Enable input turns off Q195 to enable the Z-Axis multivibrator (Q211-Q218). The duty cycle and pulse width are adjustable for calibration purposes. If the other three inputs to U200A are HI, each time the collector of Q218 goes HI the Z-Axis will be unblanked.

The In Sector signal from the Z-Axis control is applied to U220B to control the Frame/Locator unblank signal to the Display Controller. The signal is HI for In Sector and LO for out of sector.

GDC POWER SUPPLY

+15 Volt Supply

Voltage from a secondary winding of T4 is full-wave rectified by CR31, CR32, CR33, CR34 and developed across C10. Series regulator Q21 and voltage divider R45, R46, R47, and R48 reduce the output to +15 volts. The regulated output is controlled by feeding a portion of the output from the wiper of R47 to the inverting input of error amplifier U40. R45 is a current limiting resistor. If the load current becomes excessive, the IR drop across R45 applied to U40 pins 2 and 3 (current sensing input) will

move the base of Q21 toward cutoff, decreasing the output voltage.

–15 Volt Supply

The –15 volt supply circuit operation is the same as for the +15 volt supply. R87 adjusts the output voltage and R85 is the load current sensing resistor.

+5 Volt Supply

Voltage from a secondary winding of T4 is full-wave rectified by diode bridge CR11, CR12, CR13, CR14 and developed across C11. The reference voltage applied to the non-inverting input (pin 5 of U60) is obtained from the +15 volt supply. Therefore, the accuracy of the +5 volt supply is dependent upon the accuracy of the +15 volt output.

Over-voltage protection is provided by Q54, Q16, and Fuse F11. Q54 is normally biased off by Zener Diode VR50. The emitter of Q54 is connected to the +5 volt output. If the output rises to approximately +6.8 volts, Q54 collector current through R54 becomes great enough to turn Q16 on to short-circuit the full-wave rectifier, blowing Fuse F11.

Primary Power Circuit

The Primary Circuit of the supply transformer is equipped with a Line Voltage Selector Assembly (S2), Thermal Cutout Switch (S4), Power Switch (S1), Electro-Magnetic Interference Filter, Power Plug (P1), and Display Unit Outlet (J152). The Line Voltage Selector Assembly is a pull-out block that permits easy switching between 115 VAC and 230 VAC operation. Proper fuse selection accompanies the switching. A switch in the assembly permits selection of low, medium, or high operating range. Also, a special switching circuit for the power out to the Display Unit prevents the Display Unit from being powered up unless its Line Selector Assembly matches the GDC.

CARD Acc-4 (A)

Software Interrupt Number

CPU Bits 8 through 15 control the Software Interrupt Lamps. A HI on any Bit line will turn on its associated Lamp. For example, if CPU Bit 8 is HI, the Software Light Strobe will clock a HI to pin 16 of U2. This turns on Q4 to light Software Interrupt Lamp A. Any one or all of the Software Interrupt Lamps may be lighted at one time. The CPU Reset, when initiated, will pull all of Bit 8 through 15 lines LO to turn off (reset) all Software Lamps A through H.

Display Numbers

The Replot Numbers 1 through 8 are mutually exclusive (only one number can be selected and lighted at any one time). U38 is an eight-stable circuit that is switched by momentarily grounding the appropriate output. For example, a LO on Switch 1 will pull pin 1 of U38 LO, switching the other 7 outputs of U38 HI. This drives Plot No.1 to the HI or 1 level, Plot No.2 to the LO or zero level, and Plot No.4 to the LO or zero level, for a 001 BCD output of the circuit. The following chart gives the BCD output for each Switch closure (only one switch may be closed at any one time).

Switch Closed	BCD Output		
	PLOT No. 4	PLOT No.2	PLOT No. 1
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1
8	0	0	0

CARD Acc-4

Software Control Board

Button interrupt numbers A through H (only one of which may be closed at any one time) are applied to U60 to inform the computer of a button interrupt request. For example, if button interrupt number E is pressed, pin 8 of U60 goes HI to trigger U24. The positive-going pulse from U24 pin 11 is RC coupled to pin 13 to trigger the second section of U24, which latches up, since its output on pin 12 is fed back to input pin 14. The HI on pin 12 turns on Q72 to light the interrupt sending light and is sent to the computer as a button interrupt request. The circuit may be reset by a button interrupt reset from the computer, or an Initial or P.O. Reset applied to U24 pins 2 or 3, which turns on Q86 to disable the latch.

Pressing the button interrupt E also places a LO on pin 6 of U40 to send the interrupt selection to Card All (GDC Status Gate). The output of U36A, U44B, and U44A is a BCD which identifies the selected front-panel button interrupt. The BCD for each letter button is as follows:

001	A
010	B
011	C
100	D
101	E
110	F
111	G
000	H

A strappable option is provided on the Recall Scale input to allow the user to select interrupt H with the front-panel RECALL button.

CARD Acc-5, -6, -7, -8

Display Controller

Up to four separate Display Devices may be driven by the GDC at the same time. One Display Controller Card is inserted in the Drawer Unit of the GDC for each device. The description to follow is for the Display Controller Card for the Type 611. There are minor circuit differences in the Cards for other devices.

The Erase input from Mode Control (Card GC-1) is applied to U2A pin 3. If a device has been selected (U4C pin 9 HI), and Store Type encoded (U4C pin 10 HI), the Erase signal will turn on Q6 to send an erase signal to the remote device. For example, the command for select device 4 in Store Mode is Bit 14 a logical one, and Bit 15 a logical zero. This sets U12B pin 11 to logical one, and with a device selected, U12A pin 15 is also a logical one. This turns on Q20 to light the front-panel Device lamp, gates a LO to U2A pin 2, and a Store Type signal through U14 pin 4. If both CPU Bits are a logical one, the device is turned off and the front-panel Device OFF lamp is lighted. A logical one on both Bits gates a LO through U8A which sends the output of U2C HI. This HI is then inverted by U2D to clear latch U12A.

Function Reset will reset both the Write Thru (U24A-U24D) and View (U24B-U24C) latches.

CPU View and CPU Write Thru inputs are computer commands which set the View and Write Thru latches, turning on Q26 and Q28 to signal the Display Device.

When the Frame/Locator Unblank input is a logical zero and a device has been selected, U36B will gate an unblank signal to the Display Device.

In the READY Mode, with the Ready Mode and In Sector inputs a logical one, a Write command from the Z-Axis control (Card GC-7) will turn on 5 μ s timer U32. The 5 μ s LO pulse from pin 6 of U32 gates a HI on pin 6 of U40A, and if a device is selected, U14D pin 14 goes LO to send a Writing + Erase signal to the Z-Axis control to hold off the computer during a writing or erase interval. The 5 μ s pulse also resets latch U36C-U36D. At the end of the 5 μ s pulse, U36D pin 11 returns to the LO state to trigger another 5 μ s timer, U38. This gates a LO on U40B pin 8, a HI on U36A pin 3, and if a device is selected, a LO on U36B pin 6 to send a unblank pulse to the Display Device.

Circuit Description—T4005/4201

The X + Y Skip Inc (256 skip ahead) signal is applied to 65 μ s timer U34. If the display is In Sector, U34 will trigger, putting out a 65 μ s LO pulse on pin 6. This 65 μ s pulse, gated through U40A, holds off the computer until the registers have settled after a skip ahead.

Q22 is used to prevent the Type 611 from being selected in the Non-Store Mode. If Non-Store is selected, Q22 turns off and through gates U10F, U4B, and U2D, clears U12A to turn off the Type 611.

The Erase Interval input is common to all selected devices. This means that the computer can send commands no faster than the reception time of the slowest device selected.

Display Driver

The X and Y D/A inputs from the D/A Converters are applied to operational amplifiers U78 and U58 respectively. When the D/A Converters are at the Origin or Home position, their outputs are at +2.5 volts. This 2.5 volts is balanced out in the input to this circuit by R76 for the X D/A, and R56 for the Y D/A, so that a zero volt output from this Card will represent the Origin or Home Position.

Shift and Slant options are provided by this Card. There is also a strappable option in the Shift circuitry to accommodate a Display Device with the long axis mounted either vertically or horizontally.

A Shift command drops out relay K42, turning on Q46 to shift the display down (Y Down strapped) or to the left (X Left strapped).

A Slant command drops out relay K78 to feed a portion of the Y Output into the X amplifier to slant the display.

CARD Acc-9, -10

GDC Status Word

Cards Acc-9 and Acc-10 are identical. Each card has two sets of 16 bit inputs plus six gate control signals and a 16 bit output. When interfaced with the IBM 1130 computer, the full 16 bit word is used. However, an 8 bit, 12 bit, 16 bit, or 24 bit word may be used, depending on the computer being interfaced. With the IBM 1130 Cards Acc-9, Acc-10, and Acc-11 provide a choice of six device status words.

CARD Acc-11

GDC Status Gate A

Card Acc-11 functions the same as Acc-9 and Acc-10. It has two sets of 16 bit inputs, plus the six gate control signals and a 16 bit output. 8, 12, 16, or 24 bit words may be gated through.

CARD Acc-12 (For option 1)

GDC Status Word Selector

Cards Acc-9, Acc-10, and Acc-11 outputs are ORed together on this card to give a single 16 bit output, which is one of the six selectable device status words. Strappable options are provided to select the Button and Clock Interrupt Levels.

CARD Acc-12 (A)

Device Status Word (DSW) Selection

CPU Bits 8 through 11 specify which DSW the GDC is to load into the accumulator. U8 is a BCD to Decimal decoder (see following chart for Input/Output combinations).

Input/Output Chart For U8

BCD INPUT				DECIMAL OUTPUT											
D	C	B	A	0	1	2	3	4	5	6	7	8	9		
0	0	0	0	0	1	1	1	1	1	1	1	1	1		
0	0	0	1	1	0	1	1	1	1	1	1	1	1		
0	0	1	0	1	1	0	1	1	1	1	1	1	1		
0	0	1	1	1	1	1	0	1	1	1	1	1	1		
0	1	0	0	1	1	1	1	0	1	1	1	1	1		
0	1	0	1	1	1	1	1	1	0	1	1	1	1		
0	1	1	0	1	1	1	1	1	1	0	1	1	1		
0	1	1	1	1	1	1	1	1	1	1	0	1	1		
1	0	0	0	1	1	1	1	1	1	1	1	0	1		
1	0	0	1	1	1	1	1	1	1	1	1	1	0		
1	0	1	0	1	1	1	1	1	1	1	1	1	1		
1	0	1	1	1	1	1	1	1	1	1	1	1	1		
1	1	0	0	1	1	1	1	1	1	1	1	1	1		
1	1	0	1	1	1	1	1	1	1	1	1	1	1		
1	1	1	0	1	1	1	1	1	1	1	1	1	1		
1	1	1	1	0	1	1	1	1	1	1	1	1	1		
1	1	1	1	1	1	1	1	1	1	1	1	1	1		

EXAMPLE: If the CPU Bits 8 through 11 input is 0000, the direct input to U4A goes LO. The Select Status Word strobe clocks the LO through to the output of U4A, where it is inverted by U6A to pull the DSW 0 line HI. Selection of the remaining DSW's may be traced in a similar manner using the I/O chart for U8.

SECTION 3

SERVICING

Introduction

This section of the manual contains servicing information for use in preventive maintenance, corrective maintenance and troubleshooting.

Slide-Out Drawer Removal

WARNING

Dangerous potentials exist at several points throughout this instrument. When the instrument is operated with the Drawer Unit open or removed, do not touch exposed connections or components. Disconnect power before cleaning the instrument or replacing parts.

To slide out or remove the Drawer Unit, loosen the two screws at the rear of the unit which secure the Drawer Unit. Pull the Drawer outward until the stop latches snap into the holes. To remove the Drawer from the compartment, disconnect the power cord and connecting cable from the Display Unit. Press the stop latches and remove by pulling the Drawer Unit outward. Re-install the Drawer Unit by inserting into the compartment. Press the stop latches and push the Drawer into the compartment. Reconnect the power and interconnecting cable to the Display Unit.

PREVENTIVE MAINTENANCE

General

Preventive maintenance consists of cleaning, visual inspection, etc. Preventive maintenance performed on a regular basis may prevent instrument breakdown and will improve the reliability of this instrument. The severity of the environment to which it is subjected determines the frequency of maintenance. A convenient time to perform preventive maintenance is preceding recalibration of the instrument.

Cleaning

Dust in the interior of the instrument should be removed occasionally due to its electrical conductivity under high-humidity conditions. The best way to clean the interior is

to blow off the accumulated dust with dry, low-pressure air. Remove any dirt which remains with a soft paint brush or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces.

Visual Inspection

The unit should be inspected occasionally for such defects as broken connections, damaged or improperly installed circuit boards and heat-damaged parts.

The corrective procedure for most visible defects is obvious; however, particular care must be taken if heat-damaged components are found. Overheating usually indicates other trouble in the unit. It is important that the cause of overheating be corrected to prevent recurrence of the damage.

TROUBLESHOOTING

Introduction

The following information is provided to facilitate troubleshooting of the 4201 Drawer Unit. Information contained in other sections of this manual should be used with the following information to aid in locating the defective component. An understanding of the circuit operation is very helpful in locating troubles, particularly where integrated circuits are used. See the Circuit Description Section for complete information.

Troubleshooting Aids

Diagrams. Complete circuit diagrams are given on fold-out pages in the Diagrams Section. The component number and electrical value of each component in this unit are shown on the diagrams.

Circuit Boards. The circuit board pictures are shown in the Diagrams Section. Each electrical component on the boards is identified by its circuit number. These pictures, used with the diagrams aid in locating the components mounted on the circuit boards.

Interconnections. The 4201 INPUT/OUTPUT INTER-FACE BUS connections are given in Section 1 of this manual.

Resistor Color-Code. In addition to the brown composition resistors, some metal-film resistors and some wire-wound resistors are used. The resistance values of wire-wound resistors are printed on the body of the component. The resistance values of composition resistors and metal-film resistors are color-coded on the components with EIA color-code (some metal-film resistors may have the value printed on the body). The color-code is read starting with the stripe nearest the end of the resistor. Composition resistors have four stripes which consist of two significant figures, a multiplier and a tolerance value (see Fig. 3-1). Metal-film resistors have five stripes consisting of three significant figures, a multiplier and a tolerance value.

Capacitor Marking. The capacitance values of common disc capacitors and small electrolytics are marked in microfarads on the side of the component body. The white ceramic capacitors are color-coded in picofarads using a modified EIA code (see Fig. 3-1).

Diode Color-Code. The cathode end of each glass-encased diode is indicated by a stripe, a series of stripes or a dot. For most silicon or germanium diodes with a series of

stripes, the color-code identifies the three significant digits of the Tektronix Part Number using the resistor color-code system (e.g., a diode color-coded pink-, or blue-, brown-gray-green indicates Tektronix Part No. 152-0185-00). The cathode and anode ends of metal-encased diodes can be identified by the diode symbol marked on the body.

Semiconductor Lead Configuration. Fig. 3-2 shows the lead configuration for the semiconductors used in this instrument. Sockets are provided for the 8 and 10 pin integrated circuits; other semiconductors are soldered in.

Troubleshooting Equipment

The following equipment is useful for troubleshooting.

1. Dynamic Transistor Tester

Description: Tektronix Type 576 Transistor-Curve Tracer or equivalent.

Purpose: To test the semiconductors used in this unit.

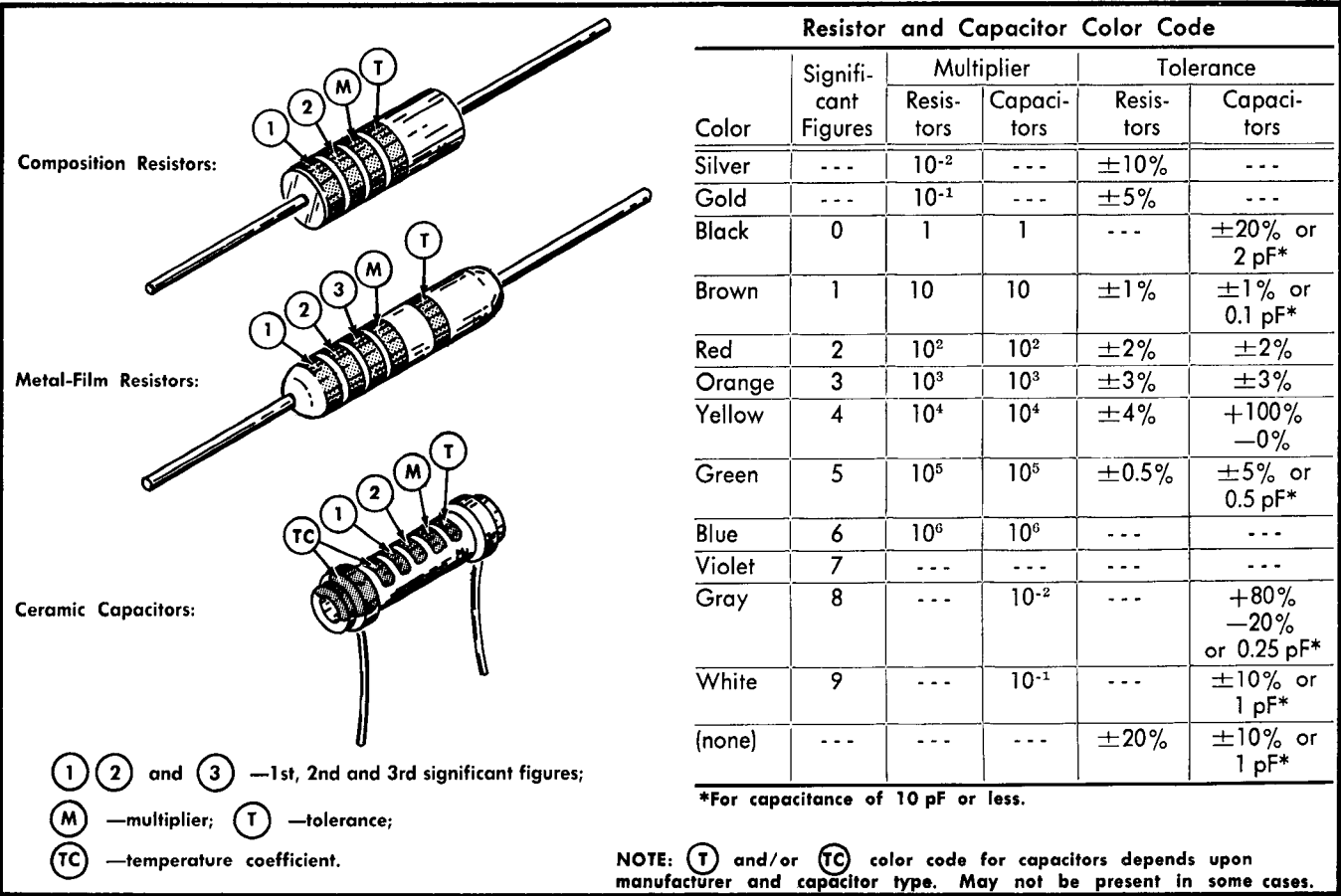


Fig. 3-1. Resistor and ceramic capacitor color-code.

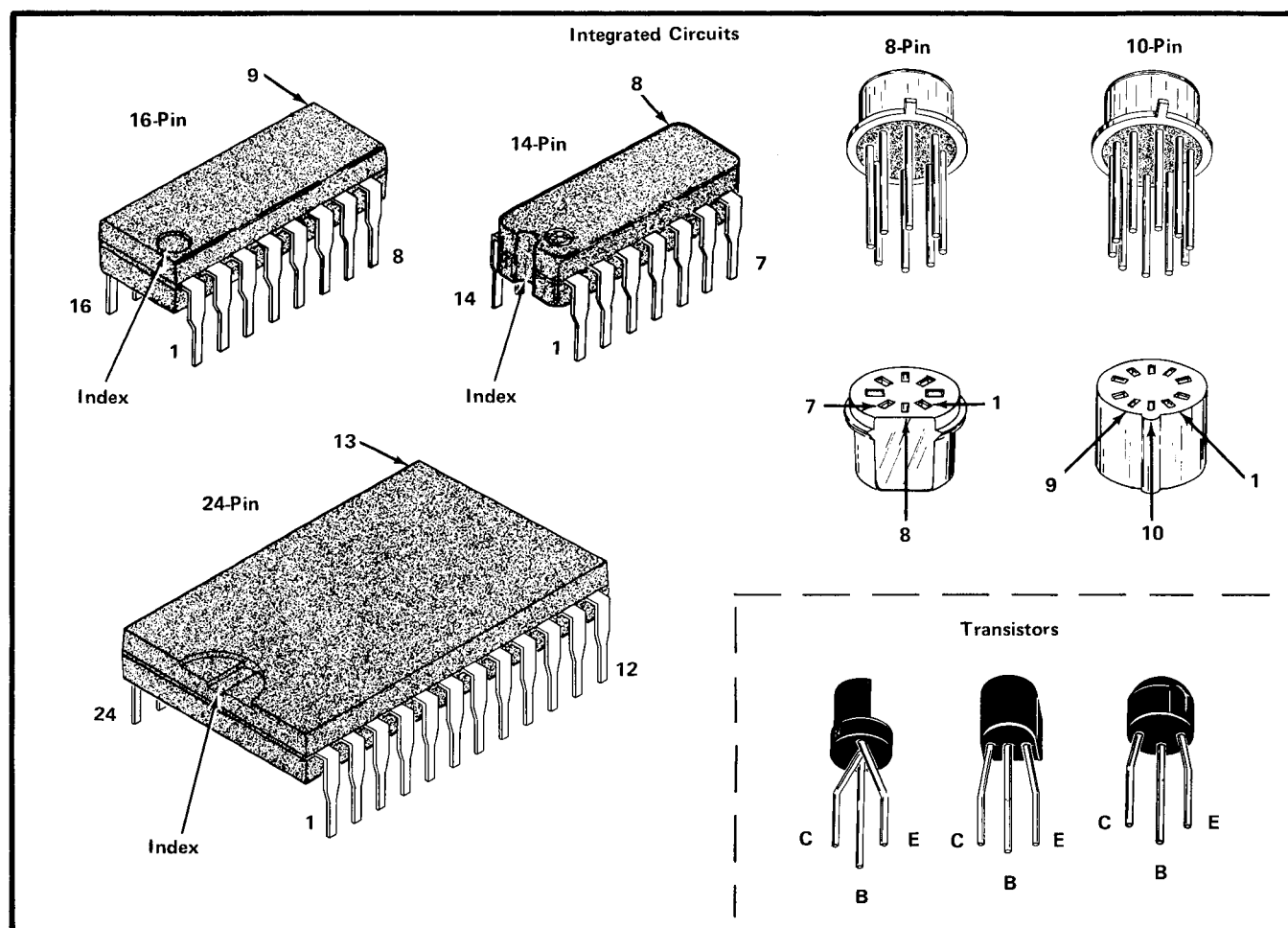


Fig. 3-2. Transistor and integrated circuit pin arrangement.

2. Volt-Ohmmeter

Description: 20,000 ohms/volt; 0 to 500 voltage range; accurate within 3%. Test probes must be well-insulated.

Purpose: To measure voltages and resistances.

3. Test Oscilloscope

Description: DC to above 5 MHz frequency response; 5 millivolts to 5 volts/division deflection factor. Use a 10X attenuator probe to prevent circuit loading.

Purpose: To check waveforms in the instrument.

Troubleshooting Techniques

1. Check control Settings. Incorrect control settings can indicate a trouble that does not exist. If there is any question about the correct function or operation of any control, refer to the T4005/4201 Users' Manual for operating instructions.

2. Visual Check. Visually check the portion of the instrument in which the trouble is located. Many troubles can be located by visual indications such as unsoldered connections, damaged components, etc.

3. Check Voltages and Waveforms. Often the defective component can be located by checking for the correct voltage or waveform in the circuit.

4. Check Individual Components. The following procedure describes methods of checking individual components. Resistors, capacitors, and diodes which are soldered in place are best checked with one end disconnected. This isolates the measurement from the surrounding circuitry.

A. DIODES

A diode can be checked for an open or shorted condition by measuring the resistance between terminals. Use an ohmmeter scale having an internal source of between

800 millivolts and 3 volts. The resistance should be high in one direction, and low when the meter leads are reversed.

CAUTION

Do not use an ohmmeter scale that has a high internal current. High current may damage the diode.

B. RESISTORS

Check the resistors with an ohmmeter. See the Electrical Parts List for the tolerance of the resistors.

C. CAPACITORS

A leaky or shorted capacitor can best be detected by checking the resistance with an ohmmeter on the highest scale. Do not exceed the voltage rating of the capacitor. The resistance reading should be high after initial charge of the capacitor. An open capacitor can best be detected with a capacitance meter or by checking whether the capacitor passes AC signals.

D. SEMICONDUCTORS

CAUTION

Power switch must be turned off before removing or replacing semiconductors.

A good check of transistor operation is actual performance under operating conditions. A transistor can most effectively be checked by substituting a new transistor, or one which has been checked previously. However, be sure that circuit conditions are not such that a replacement transistor might also be damaged. If substitute transistors are not available, use a dynamic tester. Static-type testers are not recommended, since they do not check operation under simulated operating conditions. A de-soldering tool must be used to remove transistors. See component replacement procedure for details.

Integrated circuits can be checked with a voltmeter, test oscilloscope, or by direct substitution. A good understanding of the circuit description is essential to troubleshooting circuits using integrated circuits. In addition, logic levels and other operating information for the integrated circuits are given in the Circuit Description section. Use care when checking voltages and waveforms around the integrated circuits so that adjacent leads are not shorted together. A convenient means of clipping a test probe to the 14 and 16 pin integrated circuits is with an integrated-circuit test clip. A de-soldering tool (solder sucker) must be used to remove the integrated circuits

CORRECTIVE MAINTENANCE

General

Corrective maintenance consists of component replacement and instrument repair. Special techniques required to replace components in this instrument are given here.

Obtaining Replacement Parts

Standard Parts. All electrical and mechanical part replacements may be obtained through your local Tektronix Field Office or representative. However, many of the standard electronic components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating, and description. All replacement parts should be direct replacements unless it is known that a different component will not adversely affect instrument performance.

Special Parts. In addition to the standard electronic components, some special parts are used in this instrument. These parts are manufactured or selected by Tektronix, Inc. to meet specific performance requirements, or are manufactured for Tektronix Inc. in accordance with our specifications. These special parts are indicated in the Electrical Parts List by an asterisk preceding the part number. Most of the mechanical parts have been manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative.

Ordering Parts. When ordering replacement parts from Tektronix, Inc., include the following information:

1. Instrument Type.
2. Instrument Serial Number.
3. A description of the part (if electrical, include circuit number).
4. Tektronix Part Number.

Soldering Techniques

WARNING

Disconnect the unit from the power source before soldering.

Circuit Boards. The components (except semiconductor devices) mounted on the circuit boards can be replaced using normal circuit board soldering techniques. Keep the following points in mind when soldering on the circuit boards:

1. Use a pencil-type soldering iron with a power rating from 15 to 50 watts.
2. Apply heat from the soldering iron to the junction between the component and the circuit board.

3. Heat-shunt the lead of the component by means of a pair of long-nosed pliers.

4. Avoid excessive heating of the junction, as this could separate the circuit board wiring from the laminate.

5. Use electronic grade 60-40 tin-lead solder. Clip off any excess lead length and clean with a flux-removing solvent. Be careful that the solvent does not remove any printing from the circuit board.

Semiconductors. Use a vacuum-type de-soldering tool to remove the solder from the pins. A de-solder tool such as the Ungar Model 6939 De-Solder Kit is recommended. This tool releases all pins simultaneously. An extracting tool should be used to remove the 14-pin and 16-pin integrated circuits. This tool is available from Tektronix, Inc. Order Tektronix Part No. 003-0619-00. If an extracting tool is not available, pull slowly and evenly on both ends of the device. Try to avoid having one end of the integrated circuit disengaged from the socket before the other, as the pins may be damaged.

Component Replacement

WARNING

Disconnect the equipment from the power source before replacing components.

General. The exploded-view drawings associated with the Mechanical Parts List (located after the diagram section on pull-out pages) may be helpful in the removal or disassembly of individual components or sub-assemblies.

Circuit Board Replacement. If a circuit board is damaged beyond repair, the entire assembly including all soldered-on components can be replaced. Part numbers are given in the Mechanical Parts List.

Semiconductor Replacement. Replacement semiconductors should be of the original type or a direct replacement. All transistor sockets are wired for the standard basing as used for metal-case transistors. If a replacement transistor is made by a different manufacturer than the original, check the manufacturer's basing diagram for correct basing. Refer to the procedure given under Soldering Techniques for removal of semiconductors.

Adjustments

The following list of adjustments for the GDC are given for information purposes only. Special test fixtures and/or software programs are required to perform these adjustments. For more information and/or aid in performing these adjustments, contact your local Tektronix Field Office or Applications Engineer.

Card No.	Adjustment	Function	Remarks
Power	R47	+15 Volts	Adjust for +15 volts at TP +15 V.
Supply	R87	-15 Volts	Adjust for -15 volts at TP -15 V.
GC-8	R51	Y Zero Adjust	Adjust U55 output (pin 6) for zero volts ± 1 mV.
	R151	X Zero Adjust	Adjust U155 output (pin 6) for zero volts ± 1 mV.
	R61	Frame lower right-hand corner	With the GDC in Frame Mode and DISPLAY SCALE at 2K X 2K, adjust for square lower right-hand corner of Frame being displayed.
	R161	Frame lower left-hand corner	With GDC set as above, adjust for a gap at lower left-hand corner similar to gap at other corners of Frame being displayed.
	C213	Z pulse width	With Display Scale set to 8K X 8K, monitor J8B-B with oscilloscope. Adjust C213 for 0.5 μ s low time (0) pulse width.
	R215	Z period	With GDC set as above, adjust R215 for 2 μ s between low pulses.
	R6	Y Frame Amplitude	With GDC set as above, monitor output of U55. Adjust for trapezoidal waveform of 4.00 volts amplitude.
	R106	X Frame Amplitude	With GDC set as above, monitor output of U155. Adjust for trapezoidal waveform of 4.00 volts amplitude.
GC-1	R106	DC Offset Zero	Adjust for +2.5 volts at J1B-27.
	R136	D/A LSB/MSB match	Match output of LSB D/A converter to MSB D/A converter. Requires special test fixture.
GC-7	R84	DC Offset Zero	Adjust for +2.5 volts at J7B-27.
	R116	D/A LSB/MSB match	Match output of LSB D/A converter to MSB D/A converter. Requires special test fixture.
Acc-5 6,7,8	R56	Y Position	Adjust for zero voltage between pin 4 and pin 6.
	R76	X Position	Adjust for zero voltage between pin 1 and pin 3.
	R48	Shift	Adjust for 1/4 screen shift.
	R82	Slant	Adjust for correct display slant.

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

PARTS LIST ABBREVIATIONS

BHB	binding head brass	int	internal
BHS	binding head steel	lg	length or long
cap.	capacitor	met.	metal
cer	ceramic	mtg hdw	mounting hardware
comp	composition	OD	outside diameter
conn	connector	OHB	oval head brass
CRT	cathode-ray tube	OHS	oval head steel
csk	countersunk	P/O	part of
DE	double end	PHB	pan head brass
dia	diameter	PHS	pan head steel
div	division	plstc	plastic
elect.	electrolytic	PMC	paper, metal cased
EMC	electrolytic, metal cased	poly	polystyrene
EMT	electrolytic, metal tubular	prec	precision
ext	external	PT	paper, tubular
F & I	focus and intensity	PTM	paper or plastic, tubular, molded
FHB	flat head brass	RHB	round head brass
FHS	flat head steel	RHS	round head steel
Fil HB	fillister head brass	SE	single end
Fil HS	fillister head steel	SN or S/N	serial number
h	height or high	S or SW	switch
hex.	hexagonal	TC	temperature compensated
HHB	hex head brass	THB	truss head brass
HHS	hex head steel	thk	thick
HSB	hex socket brass	THS	truss head steel
HSS	hex socket steel	tub.	tubular
ID	inside diameter	var	variable
inc	incandescent	w	wide or width
		WW	wire-wound

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

SPECIAL NOTES AND SYMBOLS

×000	Part first added at this serial number
00×	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.

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SECTION 4

ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
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CHASSIS

Fan

B4	119-0215-00			Fan, axial, 115 V, 13 W
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Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C10	290-0411-00	4200 μ F	Elect.	30 V	+100%—10%
C11	290-0482-00	65,000 μ F	Elect.	12 V	+75%—10%
C19	290-0411-00	4200 μ F	Elect.	30 V	+100%—10%

Semiconductor Device, Diodes

CR11	*152-0274-00	Silicon		Replaceable by 1N1200
CR12	*152-0274-00	Silicon		Replaceable by 1N1200
CR13	*152-0274-00	Silicon		Replaceable by 1N1200
CR14	*152-0274-00	Silicon		Replaceable by 1N1200
CR24	152-0198-00	Silicon Rectifier MR 1032A, 200 V, PIV		

Fuses

F1	159-0047-00	10 A		Fast-Blo
F2	159-0021-00	2 A	3 AG	Fast-Blo
F3	159-0016-00	1½ A	3 AG	Fast-Blo
F11	159-0046-00	8 A		Fast-Blo

Connectors

J101 thru J106	131-0569-00			Receptacle, electrical, male w/25 female pin contact
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Transistors

Q16	151-0507-00	Silicon controlled rectifier TO-3		2N3669
Q21	*151-0148-00	Silicon NPN	TO-66 Tek Spec	
Q23	*151-0148-00	Silicon NPN	TO-66 Tek Spec	
Q24	151-0275-00	Silicon NPN	TO-3 2N3771	
Q27	*151-0148-00	Silicon NPN	TO-66 Tek Spec	

CHASSIS (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
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ResistorResistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R11	302-0471-00	470 Ω	$\frac{1}{2}$ W
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Switches

Wired or Unwired

S1	260-1179-00	Toggle	POWER
S2 ¹			
S3 ¹			
S4	260-0336-00	Thermo-Cutout	150°F $\pm 5^\circ$ F

Transformer

T4	*120-0677-00	Power
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A1 CONTROL PANEL Circuit Board Assembly

*670-0934-00

Complete Board

Bulbs

DS100A	*150-0048-01	Incandescent, #683 selected
DS100B	*150-0048-01	Incandescent, #683 selected
DS100C	*150-0048-01	Incandescent, #683 selected
DS100D	*150-0048-01	Incandescent, #683 selected
DS100E	*150-0048-01	Incandescent, #683 selected
DS100F	*150-0048-01	Incandescent, #683 selected
DS100G	*150-0048-01	Incandescent, #683 selected
DS100H	*150-0048-00	Incandescent, #683 selected
DS100J	*150-0048-01	Incandescent, #683 selected
DS100K	*150-0048-01	Incandescent, #683 selected
DS100L	*150-0048-01	Incandescent, #683 selected
DS100M	*150-0048-01	Incandescent, #683 selected
DS110A	*150-0048-01	Incandescent, #683 selected
DS110B	*150-0048-00	Incandescent, #683 selected
DS120A	*150-0048-01	Incandescent, #683 selected
DS120B	*150-0048-01	Incandescent, #683 selected
DS120C	*150-0048-00	Incandescent, #683 selected

¹See Mechanical Parts List. Line Voltage Selector Body.

A1 CONTROL PANEL Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
Bulbs (cont)				
DS120D	*150-0048-01			Incandescent, #683 selected
DS120E	*150-0048-01			Incandescent, #683 selected
DS130	*150-0048-01			Incandescent, #683 selected
DS135	*150-0048-01			Incandescent, #683 selected
DS140A	*150-0048-01			Incandescent, #683 selected
DS140B	*150-0048-01			Incandescent, #683 selected
DS140C	*150-0048-01			Incandescent, #683 selected
DS140D	*150-0048-01			Incandescent, #683 selected
DS140E	*150-0048-01			Incandescent, #683 selected
DS140F	*150-0048-01			Incandescent, #683 selected
DS140G	*150-0048-01			Incandescent, #683 selected
DS140H	*150-0048-01			Incandescent, #683 selected
DS140J	*150-0048-01			Incandescent, #683 selected
DS140K	*150-0048-01			Incandescent, #683 selected
DS140L	*150-0048-01			Incandescent, #683 selected
DS140M	*150-0048-01			Incandescent, #683 selected
DS140N	*150-0048-01			Incandescent, #683 selected
DS140P	*150-0048-01			Incandescent, #683 selected
DS140R	*150-0048-01			Incandescent, #683 selected
DS140S	*150-0048-01			Incandescent, #683 selected
DS145	150-0049-00	B010100	B010127	Incandescent, #6835
DS145	*150-0049-01	B010128		Incandescent, #6835 selected
DS150	150-0049-00	B010100	B010127	Incandescent, #6835
DS150	*150-0049-01	B010128		Incandescent, #6835 selected
DS155	150-0049-00	B010100	B010127	Incandescent, #6835
DS155	*150-0049-01	B010128		Incandescent, #6835 selected
DS160	150-0049-00	B010100	B010127	Incandescent, #6835
DS160	*150-0049-01	B010128		Incandescent, #6835 selected
DS165	*150-0048-01			Incandescent, #683 selected
DS170	*150-0048-01			Incandescent, #683 selected
DS175	*150-0048-01			Incandescent, #683 selected
DS180	*150-0048-01			Incandescent, #683 selected
DS185	*150-0048-01			Incandescent, #683 selected
DS190A	*150-0048-01			Incandescent, #683 selected
DS190B	*150-0048-00			Incandescent, #683 selected
DS190C	*150-0048-01			Incandescent, #683 selected
DS190D	*150-0048-01			Incandescent, #683 selected

A1 CONTROL PANEL Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description
Switches				
Wired or Unwired				
S100 ²				DISPLAY SCALE
S110 ²				AUGMENT
S120 ²				DISPLAY DEVICE
S125 ²				SETUP
S130 ²				OFFSET/SCALE
S135 ²				ERASE
S140 ²				SOFTWARE CONTROL-DISPLAY NUMBER
S165 ²				READY
S170 ²				FRAME
S175 ²				LOCATE
S180 ²				FAST
S185 ²				HOME
S190 ²				OFFSET

A2 GC1 MODE CONTROL Circuit Card Assembly

*670-0916-00

Complete Card

CapacitorsTolerance $\pm 20\%$ unless otherwise indicated.

C5	283-0004-00	0.02 μF	Cer	150 V	
C13	283-0004-00	0.02 μF	Cer	150 V	
C25	283-0004-00	0.02 μF	Cer	150 V	
C34	281-0550-00	120 pF	Cer	500 V	10%
C38	290-0247-00	5.6 μF	Elect.	6 V	
C39	290-0267-00	1 μF	Elect.	35 V	
C48	283-0059-00	1 μF	Cer	25 V	+80%—20%
C49	283-0059-00	1 μF	Cer	25 V	+80%—20%
C52	283-0004-00	0.02 μF	Cer	150 V	
C62	283-0189-00	0.1 μF	Cer	400 V	
C69	290-0267-00	1 μF	Elect.	35 V	
C91	290-0261-00	6.8 μF	Elect.	35 V	
C95	283-0067-00	0.001 μF	Cer	200 V	10%
C96	283-0067-00	0.001 μF	Cer	200 V	10%
C99	281-0523-00	100 pF	Cer	350 V	

²See Mechanical Parts List for replacement parts.

A2 GC1 MODE CONTROL Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
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Capacitors (cont)

C103	281-0518-00	47 pF	Cer 500 V
C151	283-0059-00	1 μ F	Cer 25 V +80%—20%
C152	283-0059-00	1 μ F	Cer 25 V +80%—20%
C153	283-0059-00	1 μ F	Cer 25 V +80%—20%

Semiconductor Device, Diodes

CR20	*152-0075-00	Germanium	Tek Spec
CR36	*152-0185-00	Silicon	Replaceable by 1N4152
CR38	*152-0185-00	Silicon	Replaceable by 1N4152
CR40	*152-0075-00	Germanium	Tek Spec
CR66	*152-0185-00	Silicon	Replaceable by 1N4152

CR78	*152-0075-00	Germanium	Tek Spec
CR90	*152-0185-00	Silicon	Replaceable by 1N4152
CR98	*152-0185-00	Silicon	Replaceable by 1N4152
CR102	*152-0185-00	Silicon	Replaceable by 1N4152
CR104	*152-0185-00	Silicon	Replaceable by 1N4152

VR148	152-0217-00	Zener	1N756A 400 mW, 8.2 V, 4½%
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Relays

K38	148-0064-00	Resonant reed, spst, 500 Ω , 5 V
K102	148-0064-00	Resonant reed, spst, 500 Ω , 5 V
K104	148-0064-00	Resonant reed, spst, 500 Ω , 5 V

Transistors

Q8	151-0254-00	Silicon	NPN	TO-98 2N5308
Q18	151-0254-00	Silicon	NPN	TO-98 2N5308
Q28	151-0254-00	Silicon	NPN	TO-98 2N5308
Q32	151-0254-00	Silicon	NPN	TO-98 2N5308
Q44	151-0190-00	Silicon	NPN	TO-92 2N3904

Q56	151-0254-00	Silicon	NPN	TO-98 2N5308
Q62	151-0190-00	Silicon	NPN	TO-92 2N3904
Q82	151-0254-00	Silicon	NPN	TO-98 2N5308
Q84	151-0254-00	Silicon	NPN	TO-98 2N5308
Q86	151-0254-00	Silicon	NPN	TO-98 2N5308

Q118	151-0254-00	Silicon	NPN	TO-98 2N5308
Q138	151-0254-00	Silicon	NPN	TO-98 2N5308

A2 GC1 MODE CONTROL Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description	
Resistors				
Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.				
5R	316-0106-00		10 M Ω	$\frac{1}{4}$ W
R6	316-0101-00		100 Ω	$\frac{1}{4}$ W
R8	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R13	316-0106-00		10 M Ω	$\frac{1}{4}$ W
R14	316-0101-00		100 Ω	$\frac{1}{4}$ W
R18	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R20	315-0752-00		7.5 k Ω	$\frac{1}{4}$ W
R25	316-0106-00		10 M Ω	$\frac{1}{4}$ W
R26	316-0101-00		100 Ω	$\frac{1}{4}$ W
R28	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R32	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R34	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R36	316-0223-00		22 k Ω	$\frac{1}{4}$ W
R37	316-0223-00		22 k Ω	$\frac{1}{4}$ W
R40	315-0203-00		20 k Ω	$\frac{1}{4}$ W
R44	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R46	315-0203-00		20 k Ω	$\frac{1}{4}$ W
R52	316-0106-00		10 M Ω	$\frac{1}{4}$ W
R53	316-0101-00		100 Ω	$\frac{1}{4}$ W
R56	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R60	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R62	316-0105-00		1 M Ω	$\frac{1}{4}$ W
R63	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R65	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R66	316-0223-00		22 k Ω	$\frac{1}{4}$ W
R67	316-0223-00		22 k Ω	$\frac{1}{4}$ W
R69	316-0153-00		15 k Ω	$\frac{1}{4}$ W
R71	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R73	316-0102-00		1 k Ω	$\frac{1}{4}$ W
R76	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R78	315-0752-00		7.5 k Ω	$\frac{1}{4}$ W
R82	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R84	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R86	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R87	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R88	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R89	316-0223-00		22 k Ω	$\frac{1}{4}$ W
R90	316-0223-00		22 k Ω	$\frac{1}{4}$ W
R91	316-0153-00		15 k Ω	$\frac{1}{4}$ W

A2 GC1 MODE CONTROL Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Description			
Resistors (cont)							
R93	316-0103-00			10 kΩ	1/4 W		
R94	316-0103-00			10 kΩ	1/4 W		
R95	316-0223-00			22 kΩ	1/4 W		
R96	316-0223-00			22 kΩ	1/4 W		
R97	316-0223-00			22 kΩ	1/4 W		
R98	316-0223-00			22 kΩ	1/4 W		
R99	316-0103-00			10 kΩ	1/4 W		
R102	321-0612-01	B010100	B019999	500 Ω	1/8 W	Prec	1/2 %
R102	321-0612-07	B020000		500 Ω	1/8 W	Prec	1/10 %
R103	321-0612-01	B010100	B019999	500 Ω	1/8 W	Prec	1/2 %
R103	321-0925-07	B020000		501.5 Ω	1/8 W	Prec	1/10 %
R104	321-0184-00			806 Ω	1/8 W	Prec	1 %
R105	321-0181-00			750 Ω	1/8 W	Prec	1 %
R106	311-0900-00			10 kΩ, Var			
R107	315-0304-00			300 kΩ	1/4 W		5 %
R108	316-0471-00			470 Ω	1/4 W		
R109	316-0100-00			10 Ω	1/4 W		
R113	321-0219-00			1.87 kΩ	1/8 W	Prec	1 %
R115	321-0631-01			12.5 kΩ	1/8 W	Prec	1/2 %
R116	321-0626-01			2.51 kΩ	1/8 W	Prec	1/2 %
R117	316-0102-00			1 kΩ	1/4 W		
R118	321-0612-01			500 Ω	1/8 W	Prec	1/2 %
R120	308-0658-00			4 kΩ	1/8 W	WW	0.01 %
R121	308-0659-00			8 kΩ	1/8 W	WW	0.01 %
R122	308-0660-00			16 kΩ	1/8 W	WW	0.02 %
R123	308-0661-00			32 kΩ	1/8 W	WW	0.04 %
R124	308-0662-00			64 kΩ	1/8 W	WW	0.08 %
R133	321-0368-00			66.5 kΩ	1/8 W	Prec	1 %
R135	321-0631-01			12.5 kΩ	1/8 W	Prec	1/2 %
R136	311-0863-00			500 Ω, Var			
R137	321-0227-00			2.26 kΩ	1/8 W	Prec	1 %
R138	316-0102-00			1 kΩ	1/4 W		
R139	321-0308-00			15.8 kΩ	1/8 W	Prec	1 %
R141	308-0663-00			128 kΩ	1/8 W	WW	0.16 %
R142	322-0682-06			256 kΩ	1/4 W	Prec	1/4 %
R143	322-0683-09			512 kΩ	1/4 W	Prec	1 %
R144	322-0684-09			1.024 MΩ	1/4 W	Prec	1 %
R145	322-0684-09			1.024 MΩ	1/4 W	Prec	1 %
R146	322-0684-00			1.024 MΩ	1/4 W	Prec	1 %
R148	316-0682-00			6.8 kΩ	1/4 W		
R150	316-0102-00			1 kΩ	1/4 W		
R151	316-0100-00			10 Ω	1/4 W		
R152	316-0102-00			1 kΩ	1/4 W		
R153	316-0100-00			10 Ω	1/4 W		

A2 GC1 MODE CONTROL Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
Integrated Circuits			
U2	156-0058-00		Hex. invert. Replaceable by T.I. SN7404N
U4	156-0043-00		Quad 2-input NOR gate. Replaceable by T.I. SN7402N
U6	156-0042-00		Dual J-K flip-flop. Replaceable by T.I. SN7476N
U10	156-0058-00		Hex. invert. Replaceable by T.I. SN7404N
U12	156-0043-00		Quad 2-input NOR gate. Replaceable by T.I. SN7402N
U16	156-0043-00		Quad 2-input NOR gate. Replaceable by T.I. SN7402N
U26	156-0042-00		Dual J-K flip-flop. Replaceable by T.I. SN7476N
U30	156-0043-00		Quad 2-input NOR gate. Replaceable by T.I. SN7402N
U34	*155-0031-00		Quad timing logic, 16 pin DIP
U38	156-0081-00		Retriggerable monostable multivibrator. Replaceable by Fairchild 9601
U42	156-0030-00		Quad 2-input gate. Replaceable by T.I. SN7400N
U50	156-0036-00		Dual 4-input buffer. Replaceable by T.I. SN7440N
U64	156-0034-00		Dual 4-input gate. Replaceable by T.I. SN7420N
U66	156-0047-00		Triple 3-input gate. Replaceable by T.I. SN7410N
U70	156-0058-00		Hex. invert. Replaceable by T.I. SN7404N
U80	156-0036-00		Dual 4-input buffer. Replaceable by T.I. SN7440N
U88	156-0030-00		Quad 2-input gate. Replaceable by T.I. SN7400N
U96	156-0036-00		Dual 4-input buffer. Replaceable by T.I. SN7440N
U98	156-0036-00		Dual 4-input buffer. Replaceable by T.I. SN7440N
U104	156-0070-00		Op ampl. Replaceable by Raytheon RC4131
U106	156-0058-00		Hex. invert. Replaceable by T.I. SN7404N
U110	*155-0038-00		D-A converter
U116	156-0049-00		Op ampl. Replaceable by Fairchild μ A741C
U130	*155-0038-00		D-A converter
U136	156-0049-00		Op ampl. Replaceable by Fairchild μ A741C

A3 GCS & A4 GC6 SCALE & SECTOR Circuit Card Assembly

*670-0917-00

Complete Card

CapacitorsTolerance $\pm 20\%$ unless otherwise indicated.

C114	283-0065-00	0.001 μ F	Cer	100 V	5%
C116	283-0065-00	0.001 μ F	Cer	100 V	5%
C138	283-0059-00	1 μ F	Cer	25 V	+80%—20%
C139	283-0059-00	1 μ F	Cer	25 V	+80%—20%

A3 GCS & A4 GC6 SCALE & SECTOR Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
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Semiconductor Device, Diodes

CR40	*152-0185-00		Silicon	Replaceable by 1N4152
CR114	*152-0185-00		Silicon	Replaceable by 1N4152
CR116	*152-0185-00		Silicon	Replaceable by 1N4152

Transistors

Q12	151-0254-00		Silicon	NPN	TO-98 2N5308
Q16	151-0254-00		Silicon	NPN	TO-98 2N5308
Q20	151-0254-00		Silicon	NPN	TO-98 2N5308
Q26	151-0254-00		Silicon	NPN	TO-98 2N5308
Q34	151-0254-00		Silicon	NPN	TO-98 2N5308

Q38	151-0254-00		Silicon	NPN	TO-98 2N5308
Q40	151-0190-00		Silicon	NPN	TO-92 2N3904
Q122	151-0254-00		Silicon	NPN	TO-98 2N5308
Q124	151-0254-00		Silicon	NPN	TO-98 2N5308

Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R4	316-0102-00	1 k Ω	$\frac{1}{4}$ W
R12	316-0103-00	10 k Ω	$\frac{1}{4}$ W
R14	316-0102-00	1 k Ω	$\frac{1}{4}$ W
R16	316-0103-00	10 k Ω	$\frac{1}{4}$ W
R18	316-0102-00	1 k Ω	$\frac{1}{4}$ W

R20	316-0103-00	10 k Ω	$\frac{1}{4}$ W
R22	316-0102-00	1 k Ω	$\frac{1}{4}$ W
R26	316-0103-00	10 k Ω	$\frac{1}{4}$ W
R28	316-0102-00	1 k Ω	$\frac{1}{4}$ W
R34	316-0103-00	10 k Ω	$\frac{1}{4}$ W

R36	316-0102-00	1 k Ω	$\frac{1}{4}$ W
R38	316-0103-00	10 k Ω	$\frac{1}{4}$ W
R40	316-0103-00	10 k Ω	$\frac{1}{4}$ W
R41	316-0473-00	47 k Ω	$\frac{1}{4}$ W
R50	316-0122-00	1.2 k Ω	$\frac{1}{4}$ W

R54	316-0122-00	1.2 k Ω	$\frac{1}{4}$ W
R58	316-0122-00	1.2 k Ω	$\frac{1}{4}$ W
R62	316-0122-00	1.2 k Ω	$\frac{1}{4}$ W
R64	316-0122-00	1.2 k Ω	$\frac{1}{4}$ W
R68	316-0122-00	1.2 k Ω	$\frac{1}{4}$ W

A3 GCS & A4 GC6 SCALE & SECTOR Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
Resistors (cont)			
R70	316-0122-00	1.2 k Ω	$\frac{1}{4}$ W
R72	316-0122-00	1.2 k Ω	$\frac{1}{4}$ W
R74	316-0122-00	1.2 k Ω	$\frac{1}{4}$ W
R78	316-0122-00	1.2 k Ω	$\frac{1}{4}$ W
R84	316-0102-00	1 k Ω	$\frac{1}{4}$ W
R86	316-0182-00	1.8 k Ω	$\frac{1}{4}$ W
R90	316-0152-00	1.5 k Ω	$\frac{1}{4}$ W
R92	316-0182-00	1.8 k Ω	$\frac{1}{4}$ W
R94	315-0242-00	2.4 k Ω	$\frac{1}{4}$ W
R96	316-0332-00	3.3 k Ω	$\frac{1}{4}$ W
R98	316-0332-00	3.3 k Ω	$\frac{1}{4}$ W
R100	316-0332-00	3.3 k Ω	$\frac{1}{4}$ W
R114	316-0102-00	1 k Ω	$\frac{1}{4}$ W
R115	316-0102-00	1 k Ω	$\frac{1}{4}$ W
R116	316-0102-00	1 k Ω	$\frac{1}{4}$ W
R117	316-0102-00	1 k Ω	$\frac{1}{4}$ W
R122	316-0103-00	10 k Ω	$\frac{1}{4}$ W
R124	316-0103-00	10 k Ω	$\frac{1}{4}$ W
R125	316-0102-00	1 k Ω	$\frac{1}{4}$ W

5%

Integrated Circuits

U2	156-0047-00	Triple 3-input gate. Replaceable by T. I. SN7410N
U4	156-0036-00	Dual 4-input buffer. Replaceable by T. I. SN7440N
U6	156-0030-00	Quad 2-input gate. Replaceable by T. I. SN7400N
U8	156-0030-00	Quad 2-input gate. Replaceable by T. I. SN7400N
U10	156-0040-00	Quad latch. Replaceable by T. I. SN7475N
U18	156-0036-00	Dual 4-input buffer. Replaceable by T. I. SN7440N
U24	156-0030-00	Quad 2-input gate. Replaceable by T. I. SN7400N
U28	156-0036-00	Dual 4-input buffer. Replaceable by T. I. SN7440N
U30	156-0030-00	Quad 2-input gate. Replaceable by T. I. SN7400N
U32	156-0040-00	Quad latch. Replaceable by T. I. SN7475N
U42	156-0062-00	Quad 2-input exclusive OR gate TTL. Replaceable by T. I. SN7486N
U44	156-0043-00	Quad 2-input NOR gate. Replaceable by T. I. SN7402N
U46	156-0030-00	Quad 2-input gate. Replaceable by T. I. SN7400N
U48	156-0047-00	Triple 3-input gate. Replaceable by T. I. SN7410N
U50	156-0057-00	Quad 2-input NAND gate w/open coll. Replaceable by T. I. SN7401N

A3 GCS & A4 GC6 SCALE & SECTOR Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description
Integrated Circuits (cont)				
U52	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U54	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U56	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U58	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U60	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U62	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U64	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U66	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U68	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U70	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U72	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U74	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U76	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U78	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U80	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U82	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U84	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U86	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U88	156-0058-00			Hex. invert. Replaceable by T.I. SN7404N
U90	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U92	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U94	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U96	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U98	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U100	156-0058-00			Hex. invert. Replaceable by T.I. S..7404N

A3 GCS & A4 GC6 SCALE & SECTOR Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
Integrated Circuits (cont)			
U102	156-0030-00		Quad 2-input gate. Replaceable by T.I. SN7400N
U104	156-0043-00		Quad 2-input gate. Replaceable by T.I. SN7402N
U108	156-0043-00		Quad 2-input gate. Replaceable by T.I. SN7402N
U110	156-0030-00		Quad 2-input gate. Replaceable by T.I. SN7400N
U112	156-0035-00		8-input gate. Replaceable by T.I. SN7430N
U114	156-0035-00		8-input gate. Replaceable by T.I. SN7430N
U116	156-0034-00		Dual 4-input gate. Replaceable by T.I. SN7420N
U118	156-0035-00		8-input gate. Replaceable by T.I. SN7430N
U120	156-0043-00		Quad 2-input NOR gate. Replaceable by T.I. SN7402N
U126	156-0047-00		Triple 3-input gate. Replaceable by T.I. SN7410N
U128	156-0030-00		Quad 2-input gate. Replaceable by T.I. SN7400N
U130	156-0058-00		Hex. invert. Replaceable by T.I. SN7404N
U132	156-0043-00		Quad 2-input NOR gate. Replaceable by T.I. SN7402N
U134	156-0035-00		8-input gate. Replaceable by T.I. SN7430N
U136	156-0035-00		8-input gate. Replaceable by T.I. SN7430N

A5 GC3 & A6 GC5 POSITION REGISTER Circuit Card Assembly

*670-0918-00

Complete Card

CapacitorsTolerance $\pm 20\%$ unless otherwise indicated.

C20	281-0523-00	100 pF	Cer	350 V	
C46	281-0523-00	100 pF	Cer	350 V	
C106	283-0059-00	1 μ F	Cer	25 V	+80%—20%
C108	283-0059-00	1 μ F	Cer	25 V	+80%—20%

ResistorsResistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R2	316-0472-00	4.7 k Ω	1/4 W		
R4	316-0472-00	4.7 k Ω	1/4 W		
R20	321-0289-00	10 k Ω	1/8 W	Prec	1%
R32	316-0102-00	1 k Ω	1/4 W		
R45	316-0102-00	1 k Ω	1/4 W		
R46	321-0289-00	10 k Ω	1/8 W	Prec	1%
R76	316-0102-00	1 k Ω	1/4 W		
R104	316-0102-00	1 k Ω	1/4 W		
R105	316-0102-00	1 k Ω	1/4 W		
R106	316-0102-00	1 k Ω	1/4 W		

A5 GC3 & A6 GC5 POSITION REGISTER Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
Resistors (cont)			
R107	316-0102-00	1 k Ω	1/4 W
R108	316-0102-00	1 k Ω	1/4 W
R109	316-0102-00	1 k Ω	1/4 W
R110	316-0102-00	1 k Ω	1/4 W
Integrated Circuits			
U2	156-0043-00	Quad 2-input NOR gate. Replaceable by T.I. SN7402N	
U4	156-0030-00	Quad 2-input gate. Replaceable by T.I. SN7400N	
U6	156-0047-00	Triple 3-input gate. Replaceable by T.I. SN7410N	
U8	156-0047-00	Triple 3-input gate. Replaceable by T.I. SN7410N	
U10	156-0043-00	Quad 2-input NOR gate. Replaceable by T.I. SN7402N	
U12	156-0036-00	Dual 4-input buffer. Replaceable by T.I. SN7440N	
U14	156-0036-00	Dual 4-input buffer. Replaceable by T.I. SN7440N	
U18	156-0030-00	Quad 2-input gate. Replaceable by T.I. SN7400N	
U20	156-0081-00	Retriggerable monostable multivibrator. Replaceable by Fairchild 9601	
U22	156-0047-00	Triple 3-input gate. Replaceable by T.I. SN7410N	
U24	156-0034-00	Dual 4-input gate. Replaceable by T.I. SN7420N	
U26	156-0058-00	Hex. invert. Replaceable by T.I. SN7404N	
U28	156-0042-00	Dual J-K flip-flop. Replaceable by T.I. SN7476N	
U30	156-0047-00	Triple 3-input gate. Replaceable by T.I. SN7410N	
U32	156-0047-00	Triple 3-input gate. Replaceable by T.I. SN7410N	
U34	156-0043-00	Quad 2-input NOR gate. Replaceable by T.I. SN7402N	
U36	156-0058-00	Hex. invert. Replaceable by T.I. SN7404N	
U38	156-0040-00	Quad latch. Replaceable by T.I. SN7475N	
U40	156-0040-00	Quad latch. Replaceable by T.I. SN7475N	
U42	156-0043-00	Quad 2-input NOR gate. Replaceable by T.I. SN7402N	
U44	156-0030-00	Quad 2-input gate. Replaceable by T.I. SN7400N	
U46	156-0081-00	Retriggerable monostable multivibrator. Replaceable by Fairchild 9601	
U48	156-0030-00	Quad 2-input gate. Replaceable by T.I. SN7400N	
U50	156-0043-00	Quad 2-input NOR gate. Replaceable by T.I. SN7402N	
U52	156-0047-00	Triple 3-input gate. Replaceable by T.I. SN7410N	
U54	156-0030-00	Quad 2-input gate. Replaceable by T.I. SN7400N	
U56	156-0034-00	Dual 4-input gate. Replaceable by T.I. SN7420N	
U58	156-0035-00	8-input gate. Replaceable by T.I. SN7430N	
U60	156-0030-00	Quad 2-input gate. Replaceable by T.I. SN7400N	
U62	156-0035-00	8-input gate. Replaceable by T.I. SN7430N	
U64	156-0030-00	Quad 2-input gate. Replaceable by T.I. SN7400N	
U66	156-0042-00	Dual J-K flip-flop. Replaceable by T.I. SN7476N	
U68	156-0047-00	Triple 3-input gate. Replaceable by T.I. SN7410N	
U70	156-0047-00	Triple 3-input gate. Replaceable by T.I. SN7410N	
U72	156-0042-00	Dual J-K flip-flop. Replaceable by T.I. SN7476N	

A5 GC3 & A6 GC5 POSITION REGISTER Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
Integrated Circuits (cont)			
U74	156-0047-00		Triple 3-input gate. Replaceable by T. I. SN7410N
U76	156-0047-00		Triple 3-input gate. Replaceable by T. I. SN7410N
U78	156-0042-00		Dual J-K flip-flop. Replaceable by T. I. SN7476N
U80	156-0047-00		Triple 3-input gate. Replaceable by T. I. SN7410N
U82	156-0047-00		Triple 3-input gate. Replaceable by T. I. SN7410N
U84	156-0042-00		Dual J-K flip-flop. Replaceable by T. I. SN7476N
U88	156-0030-00		Quad 2-input gate. Replaceable by T. I. SN7400N
U90	156-0047-00		Triple 3-input gate. Replaceable by T. I. SN7410N
U92	156-0047-00		Triple 3-input gate. Replaceable by T. I. SN7410N
U94	156-0042-00		Dual J-K flip-flop. Replaceable by T. I. SN7476N
U96	156-0047-00		Triple 3-input gate. Replaceable by T. I. SN7410N
U98	156-0042-00		Dual J-K flip-flop. Replaceable by T. I. SN7476N
U100	156-0047-00		Triple 3-input gate. Replaceable by T. I. SN7410N
U102	156-0030-00		Quad 2-input gate. Replaceable by T. I. SN7400N
U104	156-0047-00		Triple 3-input gate. Replaceable by T. I. SN7410N
U106	156-0042-00		Dual J-K flip-flop. Replaceable by T. I. SN7476N
U108	156-0042-00		Dual J-K flip-flop. Replaceable by T. I. SN7476N

A7 GC4 OFFSET REGISTER & LOADER Circuit Card Assembly

*670-0919-00

Complete Card

CapacitorsTolerance $\pm 20\%$ unless otherwise indicated.

C9	283-0128-00	100 pF	Cer	500 V	5%
C14	283-0128-00	100 pF	Cer	500 V	5%
C33	283-0119-00	2200 pF	Cer	200 V	5%
C35	283-0128-00	100 pF	Cer	500 V	5%
C37	283-0128-00	100 pF	Cer	500 V	5%
C39	283-0128-00	100 pF	Cer	500 V	5%
C46	283-0059-00	1 μ F	Cer	25 V	+80%—20%
C48	283-0059-00	1 μ F	Cer	25 V	+80%—20%
C49	283-0059-00	1 μ F	Cer	25 V	+80%—20%
C59	283-0128-00	100 pF	Cer	500 V	5%
C61	283-0128-00	100 pF	Cer	500 V	5%

A7 GC4 OFFSET REGISTER & LOADER Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description		
Semiconductor Device, Diodes					
CR6	*152-0185-00	Silicon	Replaceable by 1N4152		
CR11	*152-0185-00	Silicon	Replaceable by 1N4152		
CR22	*152-0185-00	Silicon	Replaceable by 1N4152		
CR25	*152-0185-00	Silicon	Replaceable by 1N4152		
CR28	*152-0185-00	Silicon	Replaceable by 1N4152		
CR31	*152-0185-00	Silicon	Replaceable by 1N4152		
CR50	*152-0185-00	Silicon	Replaceable by 1N4152		
CR53	*152-0185-00	Silicon	Replaceable by 1N4152		
CR56	*152-0185-00	Silicon	Replaceable by 1N4152		
Resistors					
Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.					
R6	316-0223-00	22 k Ω	1/4 W	Prec	1%
R7	316-0223-00	22 k Ω	1/4 W		
R9	321-0289-00	10 k Ω	1/8 W		
R11	316-0223-00	22 k Ω	1/4 W		
R12	316-0223-00	22 k Ω	1/4 W		
R14	321-0289-00	10 k Ω	1/8 W	Prec	1%
R22	316-0223-00	22 k Ω	1/4 W		
R23	316-0223-00	22 k Ω	1/4 W		
R25	316-0223-00	22 k Ω	1/4 W		
R26	316-0223-00	22 k Ω	1/4 W		
R28	316-0223-00	22 k Ω	1/4 W		
R29	316-0223-00	22 k Ω	1/4 W		
R31	316-0223-00	22 k Ω	1/4 W		
R32	316-0223-00	22 k Ω	1/4 W		
R33	316-0103-00	10 k Ω	1/4 W		
R35	321-0289-00	10 k Ω	1/8 W	Prec	1%
R37	321-0289-00	10 k Ω	1/8 W	Prec	1%
R39	321-0289-00	10 k Ω	1/8 W	Prec	1%
R50	316-0223-00	22 k Ω	1/4 W	Prec	1%
R51	316-0223-00	22 k Ω	1/4 W		
R53	316-0223-00	22 k Ω	1/4 W	Prec	1%
R54	316-0223-00	22 k Ω	1/4 W		
R56	316-0223-00	22 k Ω	1/4 W		
R57	316-0223-00	22 k Ω	1/4 W		
R59	321-0289-00	10 k Ω	1/8 W		
R61	321-0289-00	10 k Ω	1/8 W		
R150	316-0102-00	1 k Ω	1/4 W	Prec	1%
R151	316-0102-00	1 k Ω	1/4 W		
R152	316-0102-00	1 k Ω	1/4 W		

A7 GC4 OFFSET REGISTER & LOADER Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
Integrated Circuits			
U2	156-0030-00		Quad 2-input gate. Replaceable by T.I. SN7400N
U4	156-0030-00		Quad 2-input gate. Replaceable by T.I. SN7400N
U14	*155-0031-00		Quad timing logic, 16 pin DIP
U16	156-0043-00		Quad 2-input NOR gate. Replaceable by T.I. SN7402N
U18	156-0036-00		Dual 4-input buffer. Replaceable by T.I. SN7440N
U20	156-0034-00		Dual 4-input gate. Replaceable by T.I. SN7420N
U36	*155-0031-00		Quad timing logic, 16 pin DIP
U40	156-0058-00		Hex. invert. Replaceable by T.I. SN7404N
U42	156-0036-00		Dual 4-input buffer. Replaceable by T.I. SN7440N
U44	156-0042-00		Dual J-K flip-flop. Replaceable by T.I. SN7476N
U46	156-0040-00		Quad latch. Replaceable by T.I. SN7475N
U48	156-0047-00		Triple 3-input gate. Replaceable by T.I. SN7410N
U64	156-0040-00		Quad latch. Replaceable by T.I. SN7475N
U66	156-0040-00		Quad latch. Replaceable by T.I. SN7475N
U68	156-0043-00		Quad 2-input NOR gate. Replaceable by T.I. SN7402N
U70	156-0043-00		Quad 2-input NOR gate. Replaceable by T.I. SN7402N
U72	156-0043-00		Quad 2-input NOR gate. Replaceable by T.I. SN7402N
U74	156-0043-00		Quad 2-input NOR gate. Replaceable by T.I. SN7402N
U76	156-0043-00		Quad 2-input NOR gate. Replaceable by T.I. SN7402N
U78	156-0042-00		Dual J-K flip-flop. Replaceable by T.I. SN7476N
U80	156-0047-00		Triple 3-input gate. Replaceable by T.I. SN7410N
U82	156-0030-00		Quad 2-input gate. Replaceable by T.I. SN7400N
U84	156-0042-00		Dual J-K flip-flop. Replaceable by T.I. SN7476N
U86	156-0047-00		Triple 3-input gate. Replaceable by T.I. SN7410N
U88	156-0047-00		Triple 3-input gate. Replaceable by T.I. SN7410N
U90	156-0042-00		Dual J-K flip-flop. Replaceable by T.I. SN7476N
U92	156-0030-00		Quad 2-input gate. Replaceable by T.I. SN7400N
U94	156-0047-00		Triple 3-input gate. Replaceable by T.I. SN7410N
U96	156-0042-00		Dual J-K flip-flop. Replaceable by T.I. SN7476N
U98	156-0047-00		Triple 3-input gate. Replaceable by T.I. SN7410N
U100	156-0042-00		Dual J-K flip-flop. Replaceable by T.I. SN7476N
U102	156-0037-00		Dual 2 wide 2-input and-or-invert gate. Replaceable by T.I. SN7451N
U104	156-0037-00		Dual 2 wide 2-input and-or-invert gate. Replaceable by T.I. SN7451N
U106	156-0037-00		Dual 2 wide 2-input and-or-invert gate. Replaceable by T.I. SN7451N
U108	156-0037-00		Dual 2 wide 2-input and-or-invert gate. Replaceable by T.I. SN7451N
U110	156-0037-00		Dual 2 wide 2-input and-or-invert gate. Replaceable by T.I. SN7451N
U112	156-0040-00		Quad latch. Replaceable by T.I. SN7475N
U114	156-0040-00		Quad latch. Replaceable by T.I. SN7475N
U116	156-0043-00		Quad 2-input NOR gate. Replaceable by T.I. SN7402N
U118	156-0043-00		Quad 2-input NOR gate. Replaceable by T.I. SN7402N

A7 GC4 OFFSET REGISTER & LOADER Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
Integrated Circuits (cont)			
U120	156-0043-00		Quad 2-input NOR gate. Replaceable by T.I. SN7402N
U122	156-0043-00		Quad 2-input NOR gate. Replaceable by T.I. SN7402N
U124	156-0042-00		Dual J-K flip-flop. Replaceable by T.I. SN7476N
U126	156-0047-00		Triple 3-input gate. Replaceable by T.I. SN7410N
U128	156-0030-00		Quad 2-input gate. Replaceable by T.I. SN7400N
U130	156-0042-00		Dual J-K flip-flop. Replaceable by T.I. SN7476N
U132	156-0047-00		Triple 3-input gate. Replaceable by T.I. SN7410N
U134	156-0047-00		Triple 3-input gate. Replaceable by T.I. SN7410N
U136	156-0042-00		Dual J-K flip-flop. Replaceable by T.I. SN7476N
U138	156-0030-00		Quad 2-input gate. Replaceable by T.I. SN7400N
U140	156-0047-00		Triple 3-input gate. Replaceable by T.I. SN7410N
U142	156-0042-00		Dual J-K flip-flop. Replaceable by T.I. SN7476N
U144	156-0047-00		Triple 3-input gate. Replaceable by T.I. SN7410N
U146	156-0037-00		Dual 2 wire 2-input and-or-invert gate. Replaceable by T.I. SN7451N
U148	156-0037-00		Dual 2 wire 2-input and-or-invert gate. Replaceable by T.I. SN7451N
U150	156-0037-00		Dual 2 wire 2-input and-or-invert gate. Replaceable by T.I. SN7451N
U152	156-0037-00		Dual 2 wire 2-input and-or-invert gate. Replaceable by T.I. SN7451N

A8 GC7 Z AXIS CONTROL & D/A CONVERTER Circuit Card Assembly

*670-0920-00

Complete Card

CapacitorsTolerance $\pm 20\%$ unless otherwise indicated.

C3	283-0211-00	0.1 μ F	Cer	200 V	10%
C24	281-0580-00	470 pF	Cer	500 V	10%
C27	283-0110-00	0.005 μ F	Cer	150 V	
C28	283-0110-00	0.005 μ F	Cer	150 V	
C31	283-0065-00	0.001 μ F	Cer	100 V	5%
C34	283-0065-00	0.001 μ F	Cer	100 V	5%
C40	283-0065-00	0.001 μ F	Cer	100 V	5%
C43	283-0065-00	0.001 μ F	Cer	100 V	5%
C51	281-0523-00	100 pF	Cer	350 V	
C58	281-0552-00	25 pF	Cer	500 V	

A8 GC7 Z AXIS CONTROL & D/A CONVERTER Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description			
Capacitors (cont)						
C60	283-0189-00		0.1 μ F	Cer	400 V	
C64	281-0523-00		100 pF	Cer	350 V	
C65	283-0190-00		0.47 μ F	Cer	50 V	5%
C75	283-0164-00		2.2 μ F	Cer	25 V	
C79	283-0059-00		1 μ F	Cer	25 V	+80%—20%
C81	281-0518-00		47 pF	Cer	500 V	
C131	283-0059-00		1 μ F	Cer	25 V	+80%—20%
C132	283-0059-00		1 μ F	Cer	25 V	+80%—20%
C133	283-0059-00		1 μ F	Cer	25 V	+80%—20%

Semiconductor Device, Diodes

CR1	*152-0185-00	Silicon	Replaceable by 1N4152
CR26	*152-0185-00	Silicon	Replaceable by 1N4152
CR28	*152-0185-00	Silicon	Replaceable by 1N4152
CR31	*152-0185-00	Silicon	Replaceable by 1N4152
CR34	*152-0185-00	Silicon	Replaceable by 1N4152
CR41	*152-0185-00	Silicon	Replaceable by 1N4152
CR43	*152-0185-00	Silicon	Replaceable by 1N4152
CR48	*152-0185-00	Silicon	Replaceable by 1N4152
CR61	*152-0185-00	Silicon	Replaceable by 1N4152
CR72	*152-0185-00	Silicon	Replaceable by 1N4152
CR80	*152-0185-00	Silicon	Replaceable by 1N4152
CR82	*152-0185-00	Silicon	Replaceable by 1N4152
VR128	152-0217-00	Zener	1N756A 400 mW, 8.2 V, 5%

Relays

K80	148-0064-00	Resonant reed, spst, 500 Ω , 5 V
K82	148-0064-00	Resonant reed, spst, 500 Ω , 5 V

Transistors

Q10	151-0254-00	Silicon	NPN	TO-98 2N5308
Q18	151-0207-00	Silicon	NPN	TO-98 2N3415
Q54	151-0223-00	Silicon	NPN	TO-18 2N4275
Q62	151-0254-00	Silicon	NPN	TO-98 2N5308
Q66	151-0190-00	Silicon	NPN	TO-92 2N3904
Q70	151-0207-00	Silicon	NPN	TO-98 2N3415
Q78	151-0254-00	Silicon	NPN	TO-98 2N5308
Q98	151-0254-00	Silicon	NPN	TO-98 2N5308
Q118	151-0254-00	Silicon	NPN	TO-98 2N5308

A8 GC7 Z AXIS CONTROL & D/A CONVERTER Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description		
Resistors					
Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.					
R1	316-0223-00	22 k Ω	$\frac{1}{4}$ W	Prec	1%
R2	316-0223-00	22 k Ω	$\frac{1}{4}$ W		
R3	321-0414-00	200 k Ω	$\frac{1}{8}$ W		
R10	316-0103-00	10 k Ω	$\frac{1}{4}$ W		
R12	316-0103-00	10 k Ω	$\frac{1}{4}$ W		
R13	316-0103-00	10 k Ω	$\frac{1}{4}$ W		
R14	316-0103-00	10 k Ω	$\frac{1}{4}$ W		
R15	316-0103-00	10 k Ω	$\frac{1}{4}$ W		
R17	316-0102-00	1 k Ω	$\frac{1}{4}$ W		
R18	316-0103-00	10 k Ω	$\frac{1}{4}$ W		
R19	316-0472-00	4.7 k Ω	$\frac{1}{4}$ W		
R20	316-0472-00	4.7 k Ω	$\frac{1}{4}$ W		
R22	316-0472-00	4.7 k Ω	$\frac{1}{4}$ W		
R24	316-0101-00	100 Ω	$\frac{1}{4}$ W		
R26	316-0392-00	3.9 k Ω	$\frac{1}{4}$ W		
R27	315-0512-00	5.1 k Ω	$\frac{1}{4}$ W		5%
R28	316-0392-00	3.9 k Ω	$\frac{1}{4}$ W		
R29	315-0512-00	5.1 k Ω	$\frac{1}{4}$ W		5%
R31	316-0102-00	1 k Ω	$\frac{1}{4}$ W		
R32	316-0102-00	1 k Ω	$\frac{1}{4}$ W		
R34	316-0102-00	1 k Ω	$\frac{1}{4}$ W		
R35	316-0102-00	1 k Ω	$\frac{1}{4}$ W		
R37	316-0102-00	1 k Ω	$\frac{1}{4}$ W		
R40	316-0102-00	1 k Ω	$\frac{1}{4}$ W		
R41	316-0102-00	1 k Ω	$\frac{1}{4}$ W		
R43	316-0102-00	1 k Ω	$\frac{1}{4}$ W		
R46	316-0222-00	2.2 k Ω	$\frac{1}{4}$ W		
R48	316-0223-00	22 k Ω	$\frac{1}{4}$ W		
R49	316-0223-00	22 k Ω	$\frac{1}{4}$ W		
R51	321-0261-00	5.11 k Ω	$\frac{1}{8}$ W	Prec	1%
R54	316-0103-00	10 k Ω	$\frac{1}{4}$ W		
R58	316-0103-00	10 k Ω	$\frac{1}{4}$ W		
R60	316-0103-00	10 k Ω	$\frac{1}{4}$ W		
R61	316-0103-00	10 k Ω	$\frac{1}{4}$ W		
R62	316-0102-00	1 k Ω	$\frac{1}{4}$ W		
R63	316-0223-00	22 k Ω	$\frac{1}{4}$ W	Prec	1%
R64	321-0289-00	10 k Ω	$\frac{1}{4}$ W		
R65	316-0153-00	15 k Ω	$\frac{1}{4}$ W		
R66	316-0103-00	10 k Ω	$\frac{1}{4}$ W		
R68	316-0222-00	2.2 k Ω	$\frac{1}{4}$ W		

A8 GC7 Z AXIS CONTROL & D/A CONVERTER Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Description			
Resistors (cont)							
R69	316-0222-00			2.2 kΩ	1/4 W		
R70	316-0102-00			1 kΩ	1/4 W		
R72	316-0223-00			22 kΩ	1/4 W		
R73	316-0223-00			22 kΩ	1/4 W		
R75	315-0204-00			200 kΩ	1/4 W		5%
R78	316-0103-00			10 kΩ	1/4 W		
R80	321-0612-01	B010100	B019999	500 Ω	1/8 W	Prec	1/2%
R80	321-0612-07	B020000		500 Ω	1/8 W	Prec	1/10%
R81	321-0612-01	B010100	B019999	500 Ω	1/8 W	Prec	1/2%
R81	321-0925-07	B020000		501.5 Ω	1/8 W	Prec	1/10%
R82	321-0184-00			806 Ω	1/8 W	Prec	1%
R83	321-0181-00			750 Ω	1/8 W	Prec	1%
R84	311-0900-00			10 kΩ, Var			
R85	315-0304-00			300 kΩ	1/4 W		5%
R86	316-0471-00			470 Ω	1/4 W		
R88	316-0100-00			10 Ω	1/4 W		
R93	321-0219-00			1.87 kΩ	1/8 W	Prec	1%
R95	321-0631-01			12.5 kΩ	1/8 W	Prec	1/2%
R96	321-0626-01			2.51 kΩ	1/8 W	Prec	1/2%
R97	316-0102-00			1 kΩ	1/4 W		
R98	321-0612-01			500 Ω	1/8 W	Prec	1/2%
R100	308-0658-00			4 kΩ	1/8 W	WW	0.01%
R101	308-0659-00			8 kΩ	1/8 W	WW	0.01%
R102	308-0660-00			16 kΩ	1/8 W	WW	0.02%
R103	308-0661-00			32 kΩ	1/8 W	WW	0.04%
R104	308-0662-00			64 kΩ	1/8 W	WW	0.08%
R113	321-0368-00			66.5 kΩ	1/8 W	Prec	1%
R115	321-0631-01			12.5 kΩ	1/8 W	Prec	1/2%
R116	311-0863-00			500 Ω, Var			
R117	321-0227-00			2.26 kΩ	1/8 W	Prec	1%
R118	316-0102-00			1 kΩ	1/4 W		
R119	321-0308-00			15.8 kΩ	1/8 W	Prec	1%
R121	308-0663-00			128 kΩ	1/4 W	WW	0.16%
R122	322-0682-06			256 kΩ	1/4 W	Prec	1/4%
R123	322-0683-09			512 kΩ	1/4 W	Prec	1%
R124	322-0684-09			1.024 MΩ	1/4 W	Prec	1%
R125	322-0684-09			1.024 MΩ	1/4 W	Prec	1%
R126	322-0684-09			1.024 MΩ	1/4 W	Prec	1%
R128	316-0682-00			6.8 kΩ	1/4 W		
R130	316-0102-00			1 kΩ	1/4 W		
R131	316-0100-00			10 Ω	1/4 W		
R133	316-0100-00			10 Ω	1/4 W		

A8 GC7 Z AXIS CONTROL & D/A CONVERTER Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
Integrated Circuits			
U2	*155-0031-00		Quad timing logic, 16 pin DIP
U4	156-0034-00		Dual 4-input gate. Replaceable by T.I. SN7420N
U6	156-0030-00		Quad 2-input gate. Replaceable by T.I. SN7400N
U8	156-0058-00		Hex invert. Replaceable by T.I. SN7404N
U12	156-0058-00		Hex invert. Replaceable by T.I. SN7404N
U14	156-0043-00		Quad 2-input NOR gate. Replaceable by T.I. SN7402N
U16	156-0036-00		Dual 4-input buffer. Replaceable by T.I. SN7440N
U20	156-0030-00		Quad 2-input gate. Replaceable by T.I. SN7400N
U24	156-0047-00		Triple 3-input gate. Replaceable by T.I. SN7410N
U26	156-0030-00		Quad 2-input gate. Replaceable by T.I. SN7400N
U28	156-0047-00		Triple 3-input gate. Replaceable by T.I. SN7410N
U44	156-0043-00		Quad 2-input NOR gate. Replaceable by T.I. SN7402N
U46	156-0030-00		Quad 2-input gate. Replaceable by T.I. SN7400N
U56	156-0043-00		Quad 2-input NOR gate. Replaceable by T.I. SN7402N
U58	156-0081-00		Retriggerable monostable multivibrator. Replaceable by Fairchild 9601
U60	156-0061-00		BCD to dec decoder. Replaceable by T.I. SN7442N
U64	156-0081-00		Retriggerable monostable multivibrator. Replaceable by Fairchild 9601
U84	156-0070-00		Op ampl. Replaceable by Raytheon RC4131
U86	156-0058-00		Hex. invert. Replaceable by T.I. SN7404N
U90	*155-0038-00		D-A converter
U96	156-0049-00		Op ampl. Replaceable by Fairchild μ A741C
U110	*155-0038-00		D-A converter
U116	156-0049-00		Op ampl. Replaceable by Fairchild μ A741C

A9 GC8 FRAME GENERATOR Circuit Card Assembly***670-0921-00****Complete Card****Capacitors**Tolerance $\pm 20\%$ unless otherwise indicated.

C1	290-0301-00	10 μ F	Elect.	20 V	10%
C2	290-0301-00	10 μ F	Elect.	20 V	10%
C3	290-0301-00	10 μ F	Elect.	20 V	10%
C4	283-0178-00	0.1 μ F	Cer	100 V	+80%—20%
C55	283-0178-00	0.1 μ F	Cer	100 V	+80%—20%

A9 GC8 FRAME GENERATOR Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description			
Capacitors (cont)						
C56	283-0178-00	0.1 μ F	Cer	100 V	+80%—20%	
C57	285-0898-00	0.47 μ F	PTM	100 V	10%	
C68	283-0110-00	0.005 μ F	Cer	150 V		
C85	285-0898-00	0.47 μ F	PTM	100 V	10%	
C87	283-0178-00	0.1 μ F	Cer	100 V	+80%—20%	
C88	283-0110-00	0.005 μ F	Cer	105 V		
C104	283-0178-00	0.1 μ F	Cer	100 V	+80%—20%	
C155	283-0178-00	0.1 μ F	Cer	100 V	+80%—20%	
C156	283-0178-00	0.1 μ F	Cer	100 V	+80%—20%	
C157	285-0898-00	0.47 μ F	PTM	100 V	10%	
C168	283-0110-00	0.005 μ F	Cer	150 V		
C200	283-0110-00	0.005 μ F	Cer	105 V		
C202	283-0110-00	0.005 μ F	Cer	150 V		
C204	283-0110-00	0.005 μ F	Cer	150 V		
C206	283-0110-00	0.005 μ F	Cer	150 V		
C210	283-0178-00	0.1 μ F	Cer	100 V	+80%—20%	
C213	281-0097-00	9-35 pF, Var				
C214	281-0504-00	10 pF	Cer	500 V	10%	
C216	283-0608-00	68 pF	Mica	500 V		

Semiconductor Device, Diodes

CR8	*152-0185-00	Silicon	Replaceable by 1N4152
CR9	*152-0185-00	Silicon	Replaceable by 1N4152
CR10	*152-0185-00	Silicon	Replaceable by 1N4152
CR11	*152-0185-00	Silicon	Replaceable by 1N4152
CR12	*152-0185-00	Silicon	Replaceable by 1N4152
CR13	*152-0185-00	Silicon	Replaceable by 1N4152
CR14	*152-0185-00	Silicon	Replaceable by 1N4152
CR15	*152-0185-00	Silicon	Replaceable by 1N4152
CR57	*152-0185-00	Silicon	Replaceable by 1N4152
CR58	*152-0185-00	Silicon	Replaceable by 1N4152
CR64	*152-0185-00	Silicon	Replaceable by 1N4152
CR65	*152-0185-00	Silicon	Replaceable by 1N4152
CR68	*152-0185-00	Silicon	Replaceable by 1N4152
CR69	*152-0185-00	Silicon	Replaceable by 1N4152
CR74	*152-0185-00	Silicon	Replaceable by 1N4152
CR75	*152-0185-00	Silicon	Replaceable by 1N4152
CR78	*152-0185-00	Silicon	Replaceable by 1N4152
CR79	*152-0185-00	Silicon	Replaceable by 1N4152
CR85	*152-0185-00	Silicon	Replaceable by 1N4152
CR91	*152-0185-00	Silicon	Replaceable by 1N4152

A9 GC8 FRAME GENERATOR Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
Semiconductor Device, Diodes (cont)			
CR95	*152-0185-00	Silicon	Replaceable by 1N4152
CR108	*152-0185-00	Silicon	Replaceable by 1N4152
CR109	*152-0185-00	Silicon	Replaceable by 1N4152
CR110	*152-0185-00	Silicon	Replaceable by 1N4152
CR111	*152-0185-00	Silicon	Replaceable by 1N4152
CR112	*152-0185-00	Silicon	Replaceable by 1N4152
CR113	*152-0185-00	Silicon	Replaceable by 1N4152
CR114	*152-0185-00	Silicon	Replaceable by 1N4152
CR115	*152-0185-00	Silicon	Replaceable by 1N4152
CR157	*152-0185-00	Silicon	Replaceable by 1N4152
CR158	*152-0185-00	Silicon	Replaceable by 1N4152
CR164	*152-0185-00	Silicon	Replaceable by 1N4152
CR165	*152-0185-00	Silicon	Replaceable by 1N4152
CR168	*152-0185-00	Silicon	Replaceable by 1N4152
CR169	*152-0185-00	Silicon	Replaceable by 1N4152
CR174	*152-0185-00	Silicon	Replaceable by 1N4152
CR175	*152-0185-00	Silicon	Replaceable by 1N4152
CR178	*152-0185-00	Silicon	Replaceable by 1N4152
CR179	*152-0185-00	Silicon	Replaceable by 1N4152
CR191	*152-0185-00	Silicon	Replaceable by 1N4152
CR201	*152-0185-00	Silicon	Replaceable by 1N4152
CR203	*152-0185-00	Silicon	Replaceable by 1N4152
CR205	*152-0185-00	Silicon	Replaceable by 1N4152
CR207	*152-0185-00	Silicon	Replaceable by 1N4152
CR214	152-0333-00	Silicon	High speed and conductance

Relays

K8	148-0064-00	Resonant reed, spst, 500 Ω , 5 V
K9	148-0064-00	Resonant reed, spst, 500 Ω , 5 V
K10	148-0064-00	Resonant reed, spst, 500 Ω , 5 V
K11	148-0064-00	Resonant reed, spst, 500 Ω , 5 V
K12	148-0064-00	Resonant reed, spst, 500 Ω , 5 V
K13	148-0064-00	Resonant reed, spst, 500 Ω , 5 V
K14	148-0064-00	Resonant reed, spst, 500 Ω , 5 V
K15	148-0064-00	Resonant reed, spst, 500 Ω , 5 V
K108	148-0064-00	Resonant reed, spst, 500 Ω , 5 V
K109	148-0064-00	Resonant reed, spst, 500 Ω , 5 V
K110	148-0064-00	Resonant reed, spst, 500 Ω , 5 V
K111	148-0064-00	Resonant reed, spst, 500 Ω , 5 V
K112	148-0064-00	Resonant reed, spst, 500 Ω , 5 V
K113	148-0064-00	Resonant reed, spst, 500 Ω , 5 V
K114	148-0064-00	Resonant reed, spst, 500 Ω , 5 V
K115	148-0064-00	Resonant reed, spst, 500 Ω , 5 V

A9 GC8 FRAME GENERATOR Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description		
Transistors					
Q23	151-0190-00	Silicon	NPN	TO-92	2N3904
Q27	151-0188-00	Silicon	PNP	TO-92	2N3906
Q33	151-0190-00	Silicon	NPN	TO-92	2N3904
Q37	151-0188-00	Silicon	PNP	TO-92	2N3906
Q43	151-0188-00	Silicon	PNP	TO-92	2N3906
Q47	151-0190-00	Silicon	NPN	TO-92	2N3904
Q83	151-0188-00	Silicon	PNP	TO-92	2N3906
Q84	151-0190-00	Silicon	NPN	TO-92	2N3904
Q87	151-0190-00	Silicon	NPN	TO-92	2N3904
Q123	151-0190-00	Silicon	NPN	TO-92	2N3904
Q127	151-0188-00	Silicon	PNP	TO-92	2N3906
Q133	151-0190-00	Silicon	NPN	TO-92	2N3904
Q137	151-0188-00	Silicon	PNP	TO-92	2N3906
Q143	151-0188-00	Silicon	PNP	TO-92	2N3906
Q147	151-0190-00	Silicon	NPN	TO-92	2N3904
Q195	151-0190-00	Silicon	NPN	TO-92	2N3904
Q211	151-0223-00	Silicon	NPN	TO-18	2N4275
Q218	151-0223-00	Silicon	NPN	TO-18	2N4275

ResistorsResistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R4	321-0001-00	10 Ω	$\frac{1}{8}$ W	Prec	1%
R6	311-0807-00	1 k Ω , Var			
R7	321-0245-00	3.49 k Ω	$\frac{1}{8}$ W	Prec	1%
R8	321-0213-00	1.62 k Ω	$\frac{1}{8}$ W	Prec	1%
R9	321-0242-00	3.24 k Ω	$\frac{1}{8}$ W	Prec	1%
R10	321-0213-00	1.62 k Ω	$\frac{1}{8}$ W	Prec	1%
R11	321-0184-00	806 Ω	$\frac{1}{8}$ W	Prec	1%
R12	321-0155-00	402 Ω	$\frac{1}{8}$ W	Prec	1%
R13	321-0126-00	200 Ω	$\frac{1}{8}$ W	Prec	1%
R14	321-0097-00	100 Ω	$\frac{1}{8}$ W	Prec	1%
R15	321-0091-00	86.6 Ω	$\frac{1}{8}$ W	Prec	1%
R16	315-0205-00	2 M Ω	$\frac{1}{4}$ W		5%
R18	315-0103-00	10 k Ω	$\frac{1}{4}$ W		5%
R19	315-0475-00	4.7 M Ω	$\frac{1}{4}$ W		5%
R20	315-0102-00	1 k Ω	$\frac{1}{4}$ W		5%
R21	315-0222-00	2.2 k Ω	$\frac{1}{4}$ W		5%
R22	315-0512-00	5.1 k Ω	$\frac{1}{4}$ W		5%
R23	315-0473-00	47 k Ω	$\frac{1}{4}$ W		5%
R24	315-0392-00	3.9 k Ω	$\frac{1}{4}$ W		5%
R25	315-0102-00	1 k Ω	$\frac{1}{4}$ W		5%

A9 GC8 FRAME GENERATOR Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description	
Resistors (cont)				
R28	315-0113-00	11 kΩ	1/4 W	5%
R31	315-0222-00	2.2 kΩ	1/4 W	5%
R32	315-0512-00	5.1 kΩ	1/4 W	5%
R33	315-0473-00	47 kΩ	1/4 W	5%
R34	315-0392-00	3.9 kΩ	1/4 W	5%
R35	315-0102-00	1 kΩ	1/4 W	5%
R37	315-0512-00	5.1 kΩ	1/4 W	5%
R41	315-0222-00	2.2 kΩ	1/4 W	5%
R42	315-0473-00	47 kΩ	1/4 W	5%
R43	315-0512-00	5.1 kΩ	1/4 W	5%
R44	315-0302-00	3 kΩ	1/4 W	5%
R45	315-0202-00	2 kΩ	1/4 W	5%
R48	315-0113-00	11 kΩ	1/4 W	5%
R50	315-0102-00	1 kΩ	1/4 W	5%
R51	311-0900-00	10 kΩ, Var		
R53	315-0205-00	2 MΩ	1/4 W	5%
R54	315-0362-00	3.6 kΩ	1/4 W	5%
R57	315-0106-00	10 MΩ	1/4 W	5%
R59	315-0470-00	47 Ω	1/4 W	5%
R60	315-0103-00	10 kΩ	1/4 W	5%
R61	311-0904-00	50 kΩ, Var		5%
R63	315-0205-00	2 MΩ	1/4 W	5%
R64	315-0103-00	10 kΩ	1/4 W	5%
R67	315-0475-00	4.7 MΩ	1/4 W	5%
R68	315-0472-00	4.7 kΩ	1/4 W	5%
R70	315-0103-00	10 kΩ	1/4 W	5%
R77	315-0475-00	4.7 MΩ	1/4 W	5%
R78	315-0472-00	4.7 kΩ	1/4 W	5%
R80	315-0102-00	1 kΩ	1/4 W	5%
R82	315-0302-00	3 kΩ	1/4 W	5%
R83	315-0202-00	2 kΩ	1/4 W	5%
R84	315-0753-00	75 kΩ	1/4 W	5%
R85	315-0753-00	75 kΩ	1/4 W	5%
R86	315-0183-00	18 kΩ	1/4 W	5%
R87	315-0100-00	10 Ω	1/4 W	5%
R88	315-0562-00	5.6 kΩ	1/4 W	5%
R90	315-0512-00	5.1 kΩ	1/4 W	5%
R91	315-0392-00	3.9 kΩ	1/4 W	5%
R94	315-0512-00	5.1 kΩ	1/4 W	5%
R95	315-0392-00	3.9 kΩ	1/4 W	5%

A9 GC8 FRAME GENERATOR Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
Resistors (cont)					
R98	315-0472-00		4.7 k Ω	$\frac{1}{4}$ W	5%
R104	321-0001-00		10 Ω	$\frac{1}{4}$ W	Prec 1%
R106	311-0807-00		1 k Ω , Var		
R107	321-0245-00		3.48 k Ω	$\frac{1}{8}$ W	Prec 1%
R108	321-0213-00		1.62 k Ω	$\frac{1}{8}$ W	Prec 1%
R109	321-0242-00		3.24 k Ω	$\frac{1}{8}$ W	Prec 1%
R110	321-0213-00		1.62 k Ω	$\frac{1}{8}$ W	Prec 1%
R111	321-0184-00		806 Ω	$\frac{1}{8}$ W	Prec 1%
R112	321-0155-00		402 Ω	$\frac{1}{8}$ W	Prec 1%
R113	321-0126-00		200 Ω	$\frac{1}{8}$ W	Prec 1%
R114	321-0097-00		100 Ω	$\frac{1}{8}$ W	Prec 1%
R115	321-0091-00		86.6 Ω	$\frac{1}{8}$ W	Prec 1%
R116	315-0205-00		2 M Ω	$\frac{1}{4}$ W	5%
R118	315-0103-00		10 k Ω	$\frac{1}{4}$ W	5%
R119	315-0475-00		4.7 M Ω	$\frac{1}{4}$ W	5%
R120	315-0102-00		1 k Ω	$\frac{1}{4}$ W	5%
R121	315-0222-00		2.2 k Ω	$\frac{1}{4}$ W	5%
R122	315-0512-00		5.1 k Ω	$\frac{1}{4}$ W	5%
R123	315-0473-00		47 k Ω	$\frac{1}{4}$ W	5%
R124	315-0392-00		3.9 k Ω	$\frac{1}{4}$ W	5%
R125	315-0102-00		1 k Ω	$\frac{1}{4}$ W	5%
R128	315-0113-00		11 k Ω	$\frac{1}{4}$ W	5%
R131	315-0222-00		2.2 k Ω	$\frac{1}{4}$ W	5%
R132	315-0512-00		5.1 k Ω	$\frac{1}{4}$ W	5%
R133	315-0473-00		47 k Ω	$\frac{1}{4}$ W	5%
R134	315-0392-00		3.9 k Ω	$\frac{1}{4}$ W	5%
R135	315-0102-00		1 k Ω	$\frac{1}{4}$ W	5%
R137	315-0512-00		5.1 k Ω	$\frac{1}{4}$ W	5%
R141	315-0222-00		2.2 k Ω	$\frac{1}{4}$ W	5%
R142	315-0473-00		47 k Ω	$\frac{1}{4}$ W	5%
R143	315-0512-00		5.1 k Ω	$\frac{1}{4}$ W	5%
R144	315-0302-00		3 k Ω	$\frac{1}{4}$ W	5%
R145	315-0202-00		2 k Ω	$\frac{1}{4}$ W	5%
R148	315-0113-00		11 k Ω	$\frac{1}{4}$ W	5%
R150	315-0102-00		1 k Ω	$\frac{1}{4}$ D	5%
R151	311-0900-00		10 k Ω , Var		
R153	315-0205-00		2 M Ω	$\frac{1}{4}$ W	5%
R154	315-0362-00		3.6 k Ω	$\frac{1}{4}$ W	5%
R157	315-0106-00		10 M Ω	$\frac{1}{4}$ W	5%
R159	315-0470-00		47 Ω	$\frac{1}{4}$ W	5%

A9 GC8 FRAME GENERATOR Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
Resistors (cont)			
R160	315-0103-00	10 k Ω	1/4 W 5%
R161	311-0904-00	50 k Ω , Var	
R163	315-0205-00	2 M Ω	1/4 W 5%
R164	315-0103-00	10 k Ω	1/4 W 5%
R167	315-0475-00	4.7 M Ω	1/4 W 5%
R168	315-0472-00	4.7 k Ω	1/4 W 5%
R170	315-0103-00	10 k Ω	1/4 W 5%
R177	315-0475-00	4.7 M Ω	1/4 W 5%
R178	315-0472-00	4.7 k Ω	1/4 W 5%
R190	315-0512-00	5.1 k Ω	1/4 W 5%
R191	315-0392-00	3.9 k Ω	1/4 W 5%
R195	315-0222-00	2.2 k Ω	1/4 W 5%
R196	315-0102-00	1 k Ω	1/4 W 5%
R200	315-0512-00	5.1 k Ω	1/4 W 5%
R201	315-0392-00	3.9 k Ω	1/4 W 5%
R202	315-0512-00	5.1 k Ω	1/4 W 5%
R203	315-0392-00	3.9 k Ω	1/4 W 5%
R204	315-0512-00	5.1 k Ω	1/4 W 5%
R205	315-0392-00	3.9 k Ω	1/4 W 5%
R206	315-0512-00	5.1 k Ω	1/4 W 5%
R207	315-0392-00	3.9 k Ω	1/4 W 5%
R210	315-0100-00	10 Ω	1/4 W 5%
R211	315-0242-00	2.4 k Ω	1/4 W 5%
R213	315-0273-00	27 k Ω	1/4 W 5%
R215	311-0904-00	50 k Ω , Var	
R216	315-0103-00	10 k Ω	1/4 W 5%
R218	315-0112-00	1.1 k Ω	1/4 W 5%
R220	315-0472-00	4.7 k Ω	1/4 W 5%
R225	315-0472-00	4.7 k Ω	1/4 W 5%
R230	315-0100-00	10 Ω	1/4 W 5%

Integrated Circuits

U8	156-0030-00	Quad 2-input gate. Replaceable by T. I. SN7400N
U11	156-0043-00	Quad 2-input NOR gate. Replaceable by T. I. SN7402N
U13	156-0030-00	Quad 2-input gate. Replaceable by T. I. SN7400N
U20	156-0030-00	Quad 2-input gate. Replaceable by T. I. SN7400N
U22	156-0030-00	Quad 2-input gate. Replaceable by T. I. SN7400N
U55	156-0049-00	Op ampl. Replaceable by Fairchild μ A741C
U65	156-0015-00	Oper ampl, TO-99
U75	156-0015-00	Oper ampl, TO-99
U90	156-0030-00	Quad 2-input gate. Replaceable by T. I. SN7400N
U108	156-0030-00	Quad 2-input gate. Replaceable by T. I. SN7400N

A9 GC8 FRAME GENERATOR Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
Integrated Circuits (cont)			
U110	156-0030-00		Quad 2-input gate. Replaceable by T. I. SN7400N
U122	156-0030-00		Quad 2-input gate. Replaceable by T. I. SN7400N
U155	156-0049-00		Op ampl. Replaceable by Fairchild μ A741C
U165	156-0015-00		Oper ampl, TO-99
U175	156-0015-00		Oper ampl, TO-99
U190	156-0030-00		Quad 2-input gate. Replaceable by T. I. SN7400N
U200	156-0034-00		Dual 4-input gate. Replaceable by T. I. SN7420N
U220	156-0030-00		Quad 2-input gate. Replaceable by T. I. SN7400N

A10 POWER SUPPLY Circuit Board Assembly***670-0933-00****Complete Board****Capacitors**Tolerance $\pm 20\%$ unless otherwise indicated.

C40	283-0164-00	2.2 μ F	Cer	25 V	
C46	290-0162-00	22 μ F	Elect.	35 V	
C47	281-0580-00	470 pF	Cer	500 V	10%
C66	290-0248-01	150 μ F	Elect.	15 V	
C67	283-0110-00	0.005 μ F	Cer	150 V	
C80	283-0164-00	2.2 μ F	Cer	25 V	
C86	290-0162-00	22 μ F	Elect.	35 V	
C87	281-0580-00	470 pF	Cer	500 V	10%

Semiconductor Device, Diodes

CR30	*152-0185-00	Silicon	Replaceable by 1N4152
CR31	152-0066-00	Silicon	1N3194
CR32	152-0066-00	Silicon	1N3194
CR33	152-0066-00	Silicon	1N3194
CR34	152-0066-00	Silicon	1N3194
CR71	152-0066-00	Silicon	1N3194
CR72	152-0066-00	Silicon	1N3194
CR73	152-0066-00	Silicon	1N3194
CR74	152-0066-00	Silicon	1N3194
VR50	152-0175-00	Zener	1N752A 400 mW, 5.6 V, 5%

Transistor

Q54	151-0188-00	Silicon	PNP TO-92 2N3906
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A10 POWER SUPPLY Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description	
Resistors				
Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.				
R30	316-0103-00	10 k Ω	$\frac{1}{4}$ W	
R31	302-0152-00	1.5 k Ω	$\frac{1}{2}$ W	
R40	315-0182-00	1.8 k Ω	$\frac{1}{4}$ W	5%
R45	307-0093-00	1.2 Ω	$\frac{1}{2}$ W	5%
R46	321-0666-00	3.04 k Ω	$\frac{1}{8}$ W	Prec 1%
R47	311-0635-00	1 k Ω , Var		
R48	321-0235-02	2.74 k Ω	$\frac{1}{8}$ W	Prec $\frac{1}{2}\%$
R50	316-0472-00	4.7 k Ω	$\frac{1}{4}$ W	
R51	316-0271-00	270 Ω	$\frac{1}{4}$ W	
R53	316-0470-00	47 Ω	$\frac{1}{4}$ W	
R54	316-0102-00	1 k Ω	$\frac{1}{4}$ W	
R60	321-0637-00	9.9 k Ω	$\frac{1}{8}$ W	Prec 1%
R61	321-0748-06	4.95 k Ω	$\frac{1}{8}$ W	Prec $\frac{1}{4}\%$
R65	301-0220-00	22 Ω	$\frac{1}{2}$ W	5%
R67	315-0332-00	3.3 k Ω	$\frac{1}{4}$ W	5%
R71	302-0152-00	1.5 k Ω	$\frac{1}{2}$ W	5%
R80	315-0182-00	1.8 k Ω	$\frac{1}{4}$ W	5%
R85	307-0093-00	1.2 Ω	$\frac{1}{2}$ W	Prec 1%
R86	321-0666-00	3.04 k Ω	$\frac{1}{8}$ W	
R87	311-0635-00	1 k Ω , Var		
R88	321-0235-02	2.74 k Ω	$\frac{1}{8}$ W	Prec $\frac{1}{2}\%$

Integrated Circuits

U40	156-0071-00	Volt reg. Replaceable by Fairchild μ A723C
U60	156-0071-00	Volt reg. Replaceable by Fairchild μ A723C
U80	156-0071-00	Volt reg. Replaceable by Fairchild μ A723C

A11 Acc4 SOFTWARE CONTROL Circuit Card Assembly

*670-0922-00

Complete Card

CapacitorsTolerance $\pm 20\%$ unless otherwise indicated.

C24	283-0103-00	180 pF	Cer	500 V	5%
C61	283-0005-00	0.01 μ F	Cer	250 V	
C64	283-0164-00	2.2 μ F	Cer	25 V	
C66	283-0005-00	0.01 μ F	Cer	250 V	
C69	281-0504-00	10 pF	Cer	500 V	10%

A11 Acc4 SOFTWARE CONTROL Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Capacitors (cont)						
C81	283-0000-00		0.001 μ F	Cer	500 V	
C88	283-0059-00		1 μ F	Cer	25 V	+80%—20%
C89	283-0059-00		1 μ F	Cer	25 V	+80%—20%

Semiconductor Device, Diodes

CR4	*152-0075-00	Germanium	Tek Spec
CR6	*152-0075-00	Germanium	Tek Spec
CR8	*152-0075-00	Germanium	Tek Spec
CR10	*152-0075-00	Germanium	Tek Spec
CR12	*152-0075-00	Germanium	Tek Spec
CR14	*152-0075-00	Germanium	Tek Spec
CR16	*152-0075-00	Germanium	Tek Spec
CR18	*152-0075-00	Germanium	Tek Spec
CR22	*152-0185-00	Silicon	Replaceable by 1N4152
CR26	*152-0185-00	Silicon	Replaceable by 1N4152
CR41	*152-0185-00	Silicon	Replaceable by 1N4152
CR42	*152-0185-00	Silicon	Replaceable by 1N4152
CR43	*152-0185-00	Silicon	Replaceable by 1N4152
CR44	*152-0185-00	Silicon	Replaceable by 1N4152
CR45	*152-0185-00	Silicon	Replaceable by 1N4152
CR46	*152-0185-00	Silicon	Replaceable by 1N4152
CR47	*152-0185-00	Silicon	Replaceable by 1N4152
CR48	*152-0185-00	Silicon	Replaceable by 1N4152
CR58	*152-0075-00	Germanium	Tek Spec
CR62	*152-0185-00	Silicon	Replaceable by 1N4152
CR68	*152-0185-00	Silicon	Replaceable by 1N4152
CR75	*152-0185-00	Silicon	Replaceable by 1N4152
CR78	*152-0185-00	Silicon	Replaceable by 1N4152
CR83	*152-0185-00	Silicon	Replaceable by 1N4152
CR86	*152-0185-00	Silicon	Replaceable by 1N4152

Transistors

Q4	151-0254-00	Silicon	NPN	TO-98 2N5308
Q6	151-0254-00	Silicon	NPN	TO-98 2N5308
Q8	151-0254-00	Silicon	NPN	TO-98 2N5308
Q10	151-0254-00	Silicon	NPN	TO-98 2N5308
Q12	151-0254-00	Silicon	NPN	TO-98 2N5308

A11 Acc4 SOFTWARE CONTROL Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
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Transistors (cont)

Q14	151-0254-00	Silicon	NPN TO-98 2N5308
Q16	151-0254-00	Silicon	NPN TO-98 2N5308
Q18	151-0254-00	Silicon	NPN TO-98 2N5308
Q28	151-0207-00	Silicon	NPN TO-98 2N3415
Q72	151-0254-00	Silicon	NPN TO-98 2N5308
Q86	151-0190-00	Silicon	NPN TO-92 2N3904

Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R4	316-0103-00	10 k Ω	1/4 W
R6	316-0103-00	10 k Ω	1/4 W
R8	316-0103-00	10 k Ω	1/4 W
R10	316-0103-00	10 k Ω	1/4 W
R12	316-0103-00	10 k Ω	1/4 W
R14	316-0103-00	10 k Ω	1/4 W
R16	316-0103-00	10 k Ω	1/4 W
R18	316-0103-00	10 k Ω	1/4 W
R22	316-0223-00	22 k Ω	1/4 W
R23	316-0223-00	22 k Ω	1/4 W
R24	316-0103-00	10 k Ω	1/4 W
R26	316-0102-00	1 k Ω	1/4 W
R27	316-0223-00	22 k Ω	1/4 W
R30	316-0102-00	1 k Ω	1/4 W
R32	316-0102-00	1 k Ω	1/4 W
R33	316-0102-00	1 k Ω	1/4 W
R34	316-0102-00	1 k Ω	1/4 W
R35	316-0102-00	1 k Ω	1/4 W
R36	316-0102-00	1 k Ω	1/4 W
R37	316-0102-00	1 k Ω	1/4 W
R38	316-0102-00	1 k Ω	1/4 W
R39	316-0102-00	1 k Ω	1/4 W
R41	316-0102-00	1 k Ω	1/4 W
R42	316-0102-00	1 k Ω	1/4 W
R43	316-0102-00	1 k Ω	1/4 W
R44	316-0102-00	1 k Ω	1/4 W
R45	316-0102-00	1 k Ω	1/4 W
R46	316-0102-00	1 k Ω	1/4 W
R47	316-0102-00	1 k Ω	1/4 W
R48	316-0102-00	1 k Ω	1/4 W

A11 Acc4 SOFTWARE CONTROL Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
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Resistors (cont)

R51	316-0102-00		1 k Ω	1/4 W
R52	316-0102-00		1 k Ω	1/4 W
R53	316-0102-00		1 k Ω	1/4 W
R54	316-0102-00		1 k Ω	1/4 W
R55	316-0102-00		1 k Ω	1/4 W

R56	316-0102-00		1 k Ω	1/4 W
R57	316-0102-00		1 k Ω	1/4 W
R58	316-0102-00		1 k Ω	1/4 W
R61	316-0223-00		22 k Ω	1/4 W
R63	316-0223-00		22 k Ω	1/4 W

R64	316-0473-00		47 k Ω	1/4 W
R66	316-0103-00		10 k Ω	1/4 W
R67	316-0223-00		22 k Ω	1/4 W
R68	316-0223-00		22 k Ω	1/4 W
R69	316-0103-00		10 k Ω	1/4 W

R72	316-0103-00		10 k Ω	1/4 W
R75	316-0223-00		22 k Ω	1/4 W
R76	316-0223-00		22 k Ω	1/4 W
R78	316-0223-00		22 k Ω	1/4 W
R79	316-0223-00		22 k Ω	1/4 W

R81	316-0103-00		10 k Ω	1/4 W
R83	316-0223-00		22 k Ω	1/4 W
R84	316-0223-00		22 k Ω	1/4 W
R86	316-0223-00		22 k Ω	1/4 W
R87	316-0223-00		22 k Ω	1/4 W

Integrated Circuits

U2	156-0040-00		Quad latch. Replaceable by T. I. SN7475N
U12	156-0040-00		Quad latch. Replaceable by T. I. SN7475N
U24	*155-0031-00		Quad timing logic, 16 pin DIP
U32	156-0034-00		Dual 4-input gate. Replaceable by T. I. SN7420N
U36	156-0034-00		Dual 4-input gate. Replaceable by T. I. SN7420N

U38	*155-0036-00		Lamp logic (8 stable) 10 pin, TO-5
U40	*155-0036-00		Lamp logic (8 stable) 10 pin, TO-5
U44	156-0034-00		Dual 4-input gate. Replaceable by T. I. SN7420N
U60	156-0035-00		8-input gate. Replaceable by T. I. SN7430N

***A12 Acc5, 6, 7, 8 DISPLAY CONTROLLER 611 Circuit Card Assembly**

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
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670-0926-00*Complete Card****Capacitors**Tolerance $\pm 20\%$ unless otherwise indicated.

C4	283-0110-00	0.005 μ F	Cer	150 V	
C18	283-0110-00	0.005 μ F	Cer	150 V	
C24	283-0083-00	0.0047 μ F	Cer	500 V	5%
C32	283-0065-00	0.001 μ F	Cer	100 V	5%
C33	283-0083-00	0.0047 μ F	Cer	500 V	5%
C34	283-0238-00	0.01 μ F	Cer	50 V	10%
C38	283-0065-00	0.001 μ F	Cer	100 V	5%
C59	281-0511-00	22 pF	Cer	500 V	10%
C79	281-0511-00	22 pF	Cer	500 V	10%
C98	281-0562-00	39 pF	Cer	500 V	
C100	281-0562-00	39 pF	Cer	500 V	
C120	283-0059-00	1 μ F	Cer	25 V	+80%—20%
C122	283-0059-00	1 μ F	Cer	25 V	+80%—20%
C123	283-0059-00	1 μ F	Cer	25 V	+80%—20%
C125	283-0059-00	1 μ F	Cer	25 V	+80%—20%

Semiconductor Device, Diodes

CR4	*152-0185-00	Silicon	Replaceable by 1N4152
CR16	*152-0185-00	Silicon	Replaceable by 1N4152
CR17	*152-0185-00	Silicon	Replaceable by 1N4152
CR30	*152-0185-00	Silicon	Replaceable by 1N4152
CR44	*152-0185-00	Silicon	Replaceable by 1N4152
CR54	152-0333-00	Silicon	High speed and conductance
CR68	152-0333-00	Silicon	High speed and conductance
CR74	152-0333-00	Silicon	High speed and conductance
CR98	152-0333-00	Silicon	High speed and conductance
CR100	152-0333-00	Silicon	High speed and conductance

Transistors

Q6	151-0254-00	Silicon	NPN	TO-98 2N5308
Q16	151-0207-00	Silicon	NPN	TO-98 2N3415
Q20	151-0254-00	Silicon	NPN	TO-98 2N5308
Q22	151-0207-00	Silicon	NPN	TO-98 2N3415
Q26	151-0207-00	Silicon	NPN	TO-98 2N3415

*Assembly A12 (Display Controller-611) is furnished with the T4005 but not with the 4201. Acc5, 6, 7, 8 consists of one circuit card. See discussion in the Operating Section of the Users Manual under the heading of Component Description.

A12 Acc5, 6, 7, 8 DISPLAY CONTROLLER 611 Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
Transistors (cont)					
Q27	151-0223-00		Silicon	NPN	TO-18 2N4275
Q28	151-0207-00		Silicon	NPN	TO-18 2N4275
Q30	151-0207-00		Silicon	NPN	TO-98 2N3415
Q31	151-0223-00		Silicon	NPN	TO-18 2N4275
Q46	151-0188-00		Silicon	PNP	TO-92 2N3906
Q90	151-0188-00		Silicon	PNP	TO-92 2N3906
Q98	151-0121-00		FET		N channel, junction type
Q100	151-0190-00		Silicon	NPN	TO-92 2N3904
Q102	151-0121-00		FET		N channel, junction type

ResistorsResistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R2	316-0562-00	5.6 k Ω	1/4 W	
R4	316-0562-00	5.6 k Ω	1/4 W	
R6	316-0562-00	5.6 k Ω	1/4 W	
R14	316-0562-00	5.6 k Ω	1/4 W	
R15	316-0562-00	5.6 k Ω	1/4 W	
R16	316-0562-00	5.6 k Ω	1/4 W	
R18	316-0336-00	33 M Ω	1/4 W	
R19	316-0470-00	47 Ω	1/4 W	
R20	316-0333-00	33 k Ω	1/4 W	
R21	316-0102-00	1 k Ω	1/4 W	
R22	316-0103-00	10 k Ω	1/4 W	
R23	316-0473-00	47 k Ω	1/4 W	
R24	315-0201-00	200 Ω	1/4 W	5%
R25	315-0222-00	2.2 k Ω	1/4 W	5%
R26	316-0562-00	5.6 k Ω	1/4 W	
R27	315-0222-00	2.2 k Ω	1/4 W	5%
R28	316-0562-00	5.6 k Ω	1/4 W	
R29	315-0472-00	4.7 k Ω	1/4 W	5%
R30	316-0393-00	39 k Ω	1/4 W	
R31	316-0822-00	8.2 k Ω	1/4 W	
R32	321-0309-00	16.2 k Ω	1/8 W	Prec 1%
R33	315-0201-00	200 Ω	1/4 W	5%
R34	321-0322-00	22.1 k Ω	1/8 W	Prec 1%
R35	315-0222-00	2.2 k Ω	1/4 W	5%
R36	315-0222-00	2.2 k Ω	1/4 W	5%
R38	321-0309-00	16.2 k Ω	1/8 W	Prec 1%
R40	316-0471-00	470 Ω	1/4 W	
R44	321-0258-00	4.75 k Ω	1/8 W	Prec 1%
R45	321-0290-00	10.2 k Ω	1/8 W	Prec 1%
R46	321-0385-00	100 k Ω	1/8 W	Prec 1%

A12 Acc5, 6, 7, 8 DISPLAY CONTROLLER 611 Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description			
Resistors (cont)						
R47	315-0393-00		39 kΩ	1/4 W		5%
R48	311-0902-00		5 kΩ, Var			
R49	321-0344-00		37.4 kΩ	1/8 W	Prec	1%
R52	321-0816-01		5 kΩ	1/8 W	Prec	1/2 %
R54	321-0333-00		28.7 kΩ	1/8 W	Prec	1%
R56	311-0940-00		2.5 kΩ, Var			
R58	315-0162-00		1.6 kΩ	1/4 W		5%
R59	321-0222-01		2 kΩ	1/8 W	Prec	1/2 %
R64	321-0094-00		93.1 kΩ	1/8 W	Prec	1%
R66	315-0102-00		1 kΩ	1/4 W		5%
R67	315-0202-00		2 kΩ	1/4 W		5%
R68	315-0133-00		13 kΩ	1/4 W		5%
R72	321-0816-01		5 kΩ	1/8 W	Prec	1/2 %
R74	321-0323-00		22.6 kΩ	1/8 W	Prec	1%
R76	311-0940-00		2.5 kΩ, Var			5%
R78	315-0152-00		1.5 kΩ	1/4 W	Prec	1/2 %
R79	321-0211-01		1.54 kΩ	1/8 W	Prec	1%
R80	321-0188-00		887 Ω	1/8 W	Prec	1%
R81	321-0105-00		121 Ω	1/8 W	Prec	1%
R82	311-1103-00		50 Ω, Var			
R84	321-0094-00		93.1 kΩ	1/8 W	Prec	1%
R90	315-0222-00		2.2 kΩ	1/4 W		5%
R91	315-0222-00		2.2 kΩ	1/4 W		5%
R93	315-0622-00		6.2 kΩ	1/4 W		5%
R94	316-0132-00		1.3 kΩ	1/4 W		
R100	315-0103-00		10 kΩ	1/4 W		5%
R103	315-0133-00		13 kΩ	1/4 W		5%
R104	315-0102-00		1 kΩ	1/4 W		5%
R110	316-0102-00		1 kΩ	1/4 W		
R111	316-0102-00		1 kΩ	1/4 W		
R120	316-0100-00		10 kΩ	1/4 W		
R125	316-0100-00		10 Ω	1/4 W		

Integrated Circuits

U2	156-0043-00	Quad 2-input NOR gate. Replaceable by T.I. SN7402N
U4	156-0030-00	Quad 2-input gate. Replaceable by T.I. SN7400N
U8	156-0047-00	Triple 3-input gate. Replaceable by T.I. SN7410N
U10	156-0058-00	Hex. invert. Replaceable by T.I. SN7404N
U12	156-0042-00	Dual J-K flip-flop. Replaceable by T.I. SN7476N

A12 Acc5, 6, 7, 8 DISPLAY CONTROLLER 611 Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
Integrated Circuits (cont)			
U14	156-0057-00		Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N
U24	156-0030-00		Quad 2-input gate. Replaceable by T.I. SN7400N
U25	156-0062-00		Quad 2-input exclusive OR gate TTL. Replaceable by T.I. SN7486N
U32	156-0081-00		Retriggerable monostable multivibrator. Replaceable by Fairchild 9601
U34	156-0081-00		Retriggerable monostable multivibrator. Replaceable by Fairchild 9601
U36	156-0030-00		Quad 2-input gate. Replaceable by T.I. SN7400N
U38	156-0081-00		Retriggerable monostable multivibrator. Replaceable by Fairchild 9601
U40	156-0034-00		Dual 4-input gate. Replaceable by T.I. SN7420N
U58	156-0070-00		Op ampl. Replaceable by Raytheon RC4131
U78	156-0070-00		Op ampl. Replaceable by Raytheon RC4131

A13 Acc9 & A14 Acc10 GDC Status Gate B, C Circuit Card Assembly***670-0927-00****Complete Card****Capacitor**Tolerance $\pm 20\%$ unless otherwise indicated.

C34	283-0059-00	1 μ F	Cer	25 V	+80%—20%
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ResistorsResistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R2	316-0472-00	4.7 k Ω	$\frac{1}{4}$ W
R4	316-0472-00	4.7 k Ω	$\frac{1}{4}$ W
R6	316-0472-00	4.7 k Ω	$\frac{1}{4}$ W
R8	316-0472-00	4.7 k Ω	$\frac{1}{4}$ W
R10	316-0472-00	4.7 k Ω	$\frac{1}{4}$ W
R12	316-0472-00	4.7 k Ω	$\frac{1}{4}$ W
R14	316-0472-00	4.7 k Ω	$\frac{1}{4}$ W
R16	316-0472-00	4.7 k Ω	$\frac{1}{4}$ W
R18	316-0472-00	4.7 k Ω	$\frac{1}{4}$ W
R20	316-0472-00	4.7 k Ω	$\frac{1}{4}$ W

A13 Acc9 & A14 Acc10 GDC Status Gate B, C Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
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Resistors (cont)

R22	316-0472-00	4.7 k Ω	1/4 W
R24	316-0472-00	4.7 k Ω	1/4 W
R26	316-0472-00	4.7 k Ω	1/4 W
R28	316-0472-00	4.7 k Ω	1/4 W
R30	316-0472-00	4.7 k Ω	1/4 W
R32	316-0472-00	4.7 k Ω	1/4 W

Integrated Circuits

U2	156-0057-00	Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N	
U6	156-0057-00	Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N	
U10	156-0057-00	Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N	
U14	156-0057-00	Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N	
U18	156-0057-00	Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N	
U22	156-0057-00	Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N	
U28	156-0057-00	Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N	
U32	156-0057-00	Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N	

A15 Acc11 GDC STATUS GATE A Circuit Card Assembly

*670-0951-00

Complete Card

CapacitorTolerance $\pm 20\%$ unless otherwise indicated.

C64	283-0059-00	1 μ F	Cer	25 V	+80%—20%
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Semiconductor Device, Diodes

CR10	*152-0185-00	Silicon	Replaceable by 1N4152
CR11	*152-0185-00	Silicon	Replaceable by 1N4152

A15 Acc11 GDC STATUS GATE A Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description
Transistor				
Q12	151-0190-00		Silicon	NPN TO-92 2N3904
Resistors				
Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.				
R2	316-0472-00		4.7 k Ω	$\frac{1}{4}$ W
R4	316-0472-00		4.7 k Ω	$\frac{1}{4}$ W
R6	316-0472-00		4.7 k Ω	$\frac{1}{4}$ W
R10	316-0472-00		4.7 k Ω	$\frac{1}{4}$ W
R12	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R14	316-0472-00		4.7 k Ω	$\frac{1}{4}$ W
R16	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R18	316-0472-00		4.7 k Ω	$\frac{1}{4}$ W
R20	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R22	316-0472-00		4.7 k Ω	$\frac{1}{4}$ W
R24	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R26	316-0472-00		4.7 k Ω	$\frac{1}{4}$ W
R28	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R30	316-0472-00		4.7 k Ω	$\frac{1}{4}$ W
R32	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R34	316-0472-00		4.7 k Ω	$\frac{1}{4}$ W
R36	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R38	316-0472-00		4.7 k Ω	$\frac{1}{4}$ W
R40	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R42	316-0472-00		4.7 k Ω	$\frac{1}{4}$ W
R44	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R46	316-0472-00		4.7 k Ω	$\frac{1}{4}$ W
R48	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R50	316-0472-00		4.7 k Ω	$\frac{1}{4}$ W
R52	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R54	316-0472-00		4.7 k Ω	$\frac{1}{4}$ W
R56	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R58	316-0472-00		4.7 k Ω	$\frac{1}{4}$ W
R60	316-0103-00		10 k Ω	$\frac{1}{4}$ W
R62	316-0472-00		4.7 k Ω	$\frac{1}{4}$ W
Integrated Circuits				
U2	156-0057-00		Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N	
U6	156-0057-00		Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N	
U14	156-0057-00		Quad 2-input NAND gate w/open coll. Replaceable by T.I. SN7401N	
U16	156-0058-00		Hex. invert. Replaceable by T.I. SN7404N	
U20	156-0058-00		Hex. invert. Replaceable by T.I. SN7404N	

A15 Acc11 GDC STATUS GATE A Circuit Card Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
Integrated Circuits (cont)				
U24	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T. I. SN7401N
U30	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T. I. SN7401N
U40	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T. I. SN7401N
U50	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T. I. SN7401N
U56	156-0057-00			Quad 2-input NAND gate w/open coll. Replaceable by T. I. SN7401N

A16 Acc12 GDC STATUS GATE SELECTOR Circuit Card Assembly

*670-0928-00

Complete Card

CapacitorsTolerance $\pm 20\%$ unless otherwise indicated.

C18	283-0059-00	1 μ F	Cer	25 V	+80%—20%
C19	283-0059-00	1 μ F	Cer	25 V	+80%—20%

ResistorsResistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R14	316-0102-00	1 k Ω	$\frac{1}{4}$ W
R15	316-0102-00	1 k Ω	$\frac{1}{4}$ W

Integrated Circuits

U2	156-0058-00	Hex invert. Replaceable by T. I. SN7404N
U4	156-0041-00	Dual D flip-flop. Replaceable by T. I. SN7474N
U6	156-0036-00	Dual 4-input buffer. Replaceable by T. I. SN7440N
U8	156-0061-00	BCD to dec decoder. Replaceable by T. I. SN7442N
U10	156-0041-00	Dual D flip-flop. Replaceable by T. I. SN7474N
U12	156-0036-00	Dual 4-input buffer. Replaceable by T. I. SN7440N
U14	156-0041-00	Dual D flip-flop. Replaceable by T. I. SN7474N
U16	156-0036-00	Dual 4-input buffer. Replaceable by T. I. SN7440N

A17 INTERCONNECT GRAPHIC Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Serial/Model No. - Eff Disc	Description
*670-0913-00			Complete Board

Connectors

J1A thru J8A	131-0762-01	Receptacle, electrical, 56 contact
J1B thru J8B	131-0762-01	Receptacle, electrical, 56 contact

A18 INTERCONNECT ACCESSORY Circuit Board Assembly


*670-0914-00	Complete Board
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Connectors

J11 thru J21	131-0762-01	Receptacle, electrical, 56 contact
J22	131-0931-01	Receptacle, electrical, 50/100 contact

SECTION 5

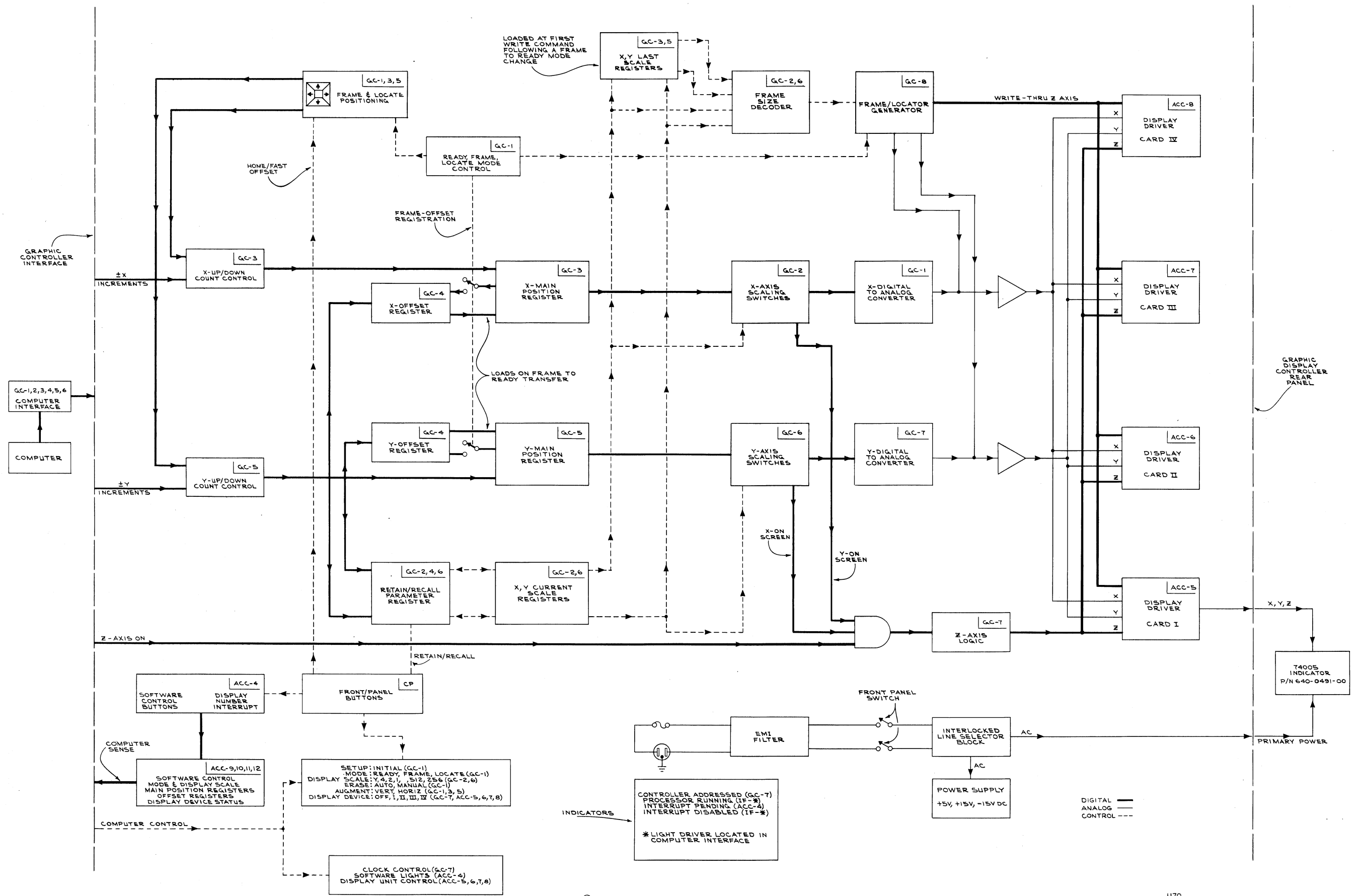
DIAGRAMS and CIRCUIT BOARD ILLUSTRATIONS

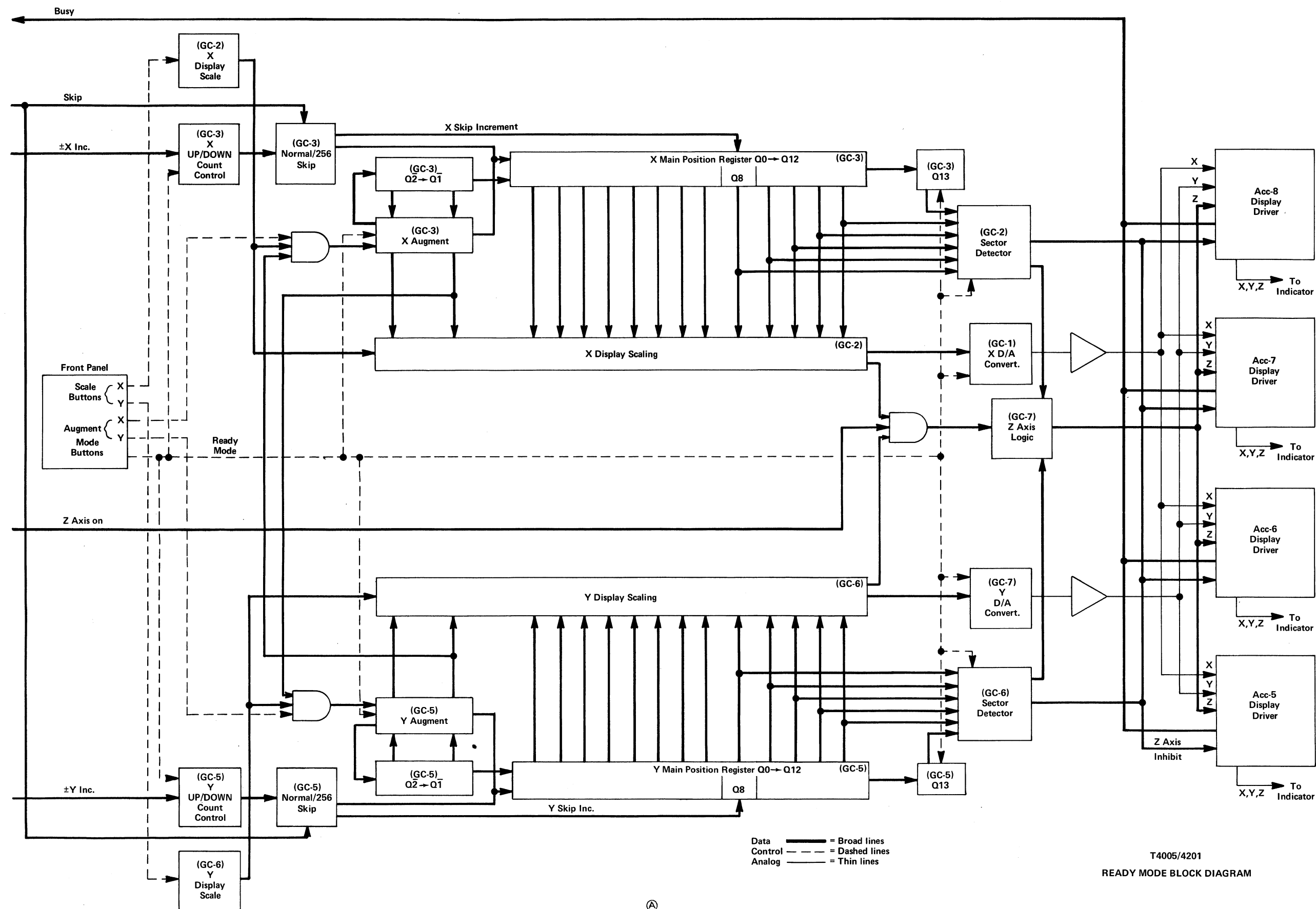
Diagram number is indicated by a number within a diamond e.g.  . The diagram number and name is shown below the diagram. Input and output leads are labeled to show the source or destination of these leads. The labeling shows diagram number, connector number, and pin number.

The number within the diamond indicates only the nearest preceding and/or following schematics, in the set, having the same signal name. Refer to the schematics indicated by the number within the diamond to determine if the signal continues to still lower or higher numbered schematics.

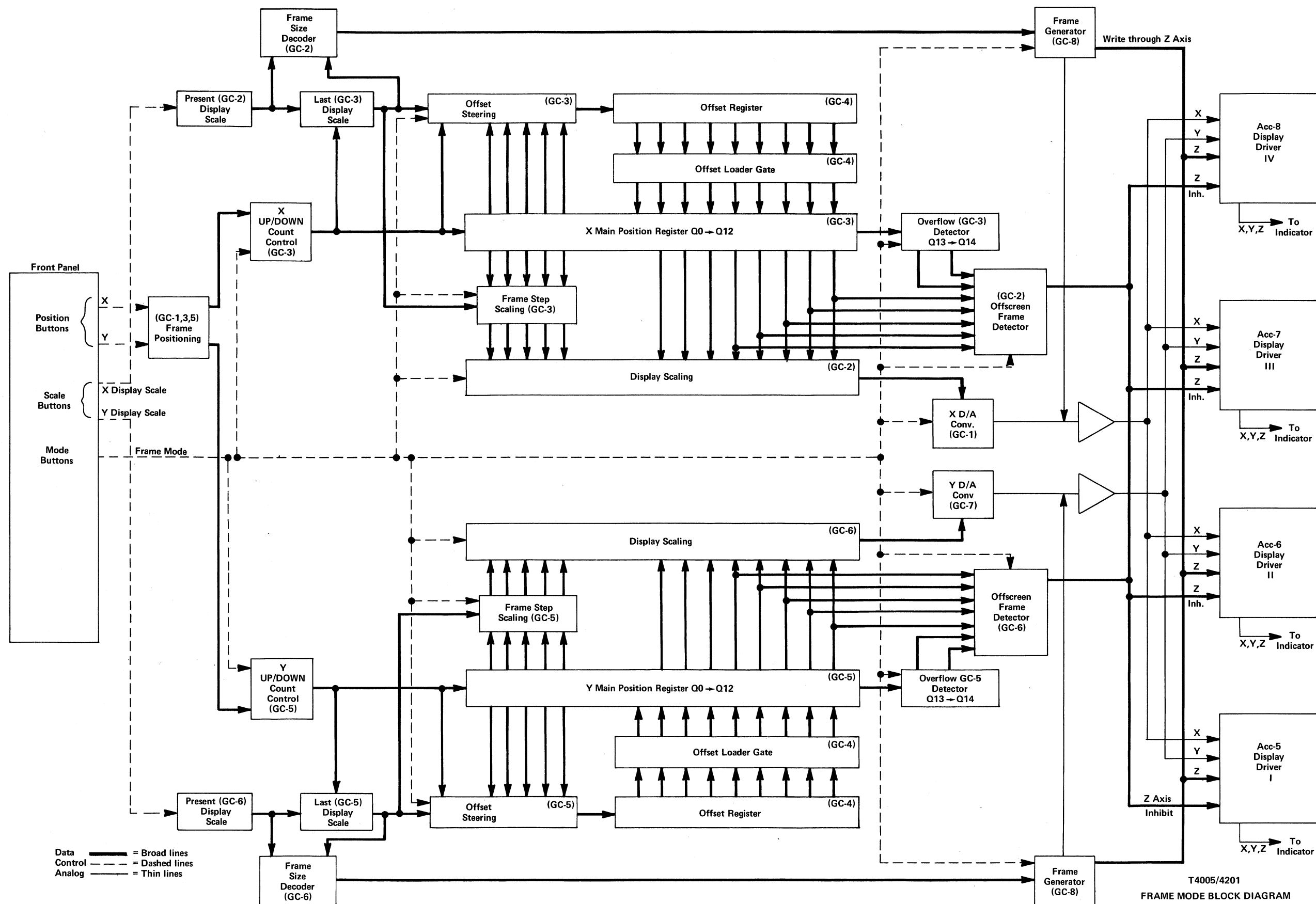
Diagram numbers are not shown for leads going to, or coming from, connectors J230, J231, J232, or J233. Connectors J230 through J233 were not provided on early instruments. On instruments without connectors J230 through J233, connecting leads run directly from connectors J130 through J133 to the Graphic and Accessory Area card connectors. These connectors interconnect the interface area of the 4201 GDC to the remainder of the drawer unit. Pins of connectors J230 through J233, on the Graphic Interconnect Board, connect to like pins of connectors J130 through J133 on the Interface Interconnect Board (e.g. pin 3 of J230 connects to pin 3 of J130). Signals connected to pins of these connectors as well as other information, is given in Section 1 of this manual (T4005/4201 Maintenance).

A useful Table, titled Interface to GDC Interconnections, is in Section 3 of your Interface manual. This table lists the signal name of lines connected to pins of connectors J230 through J233.



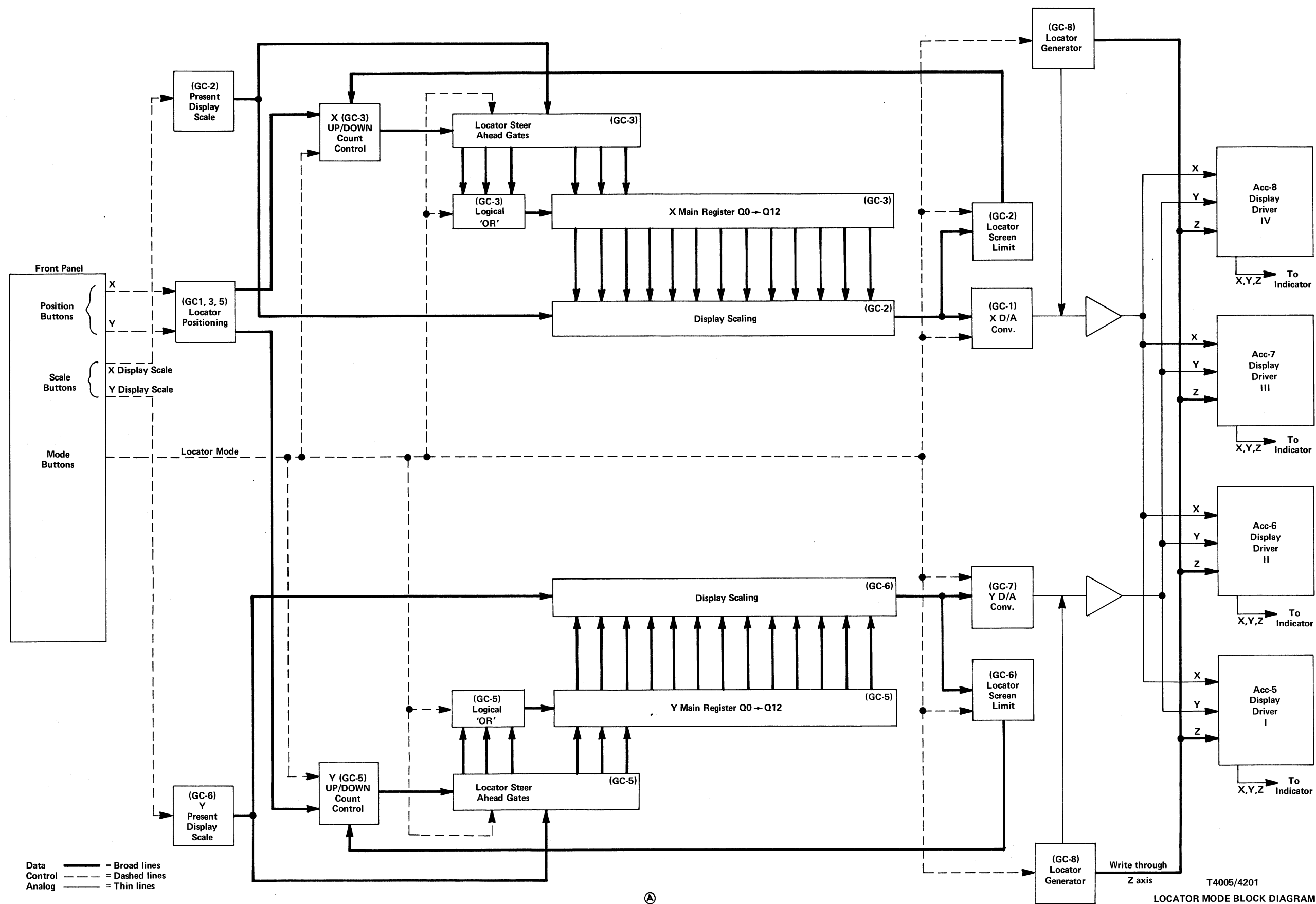


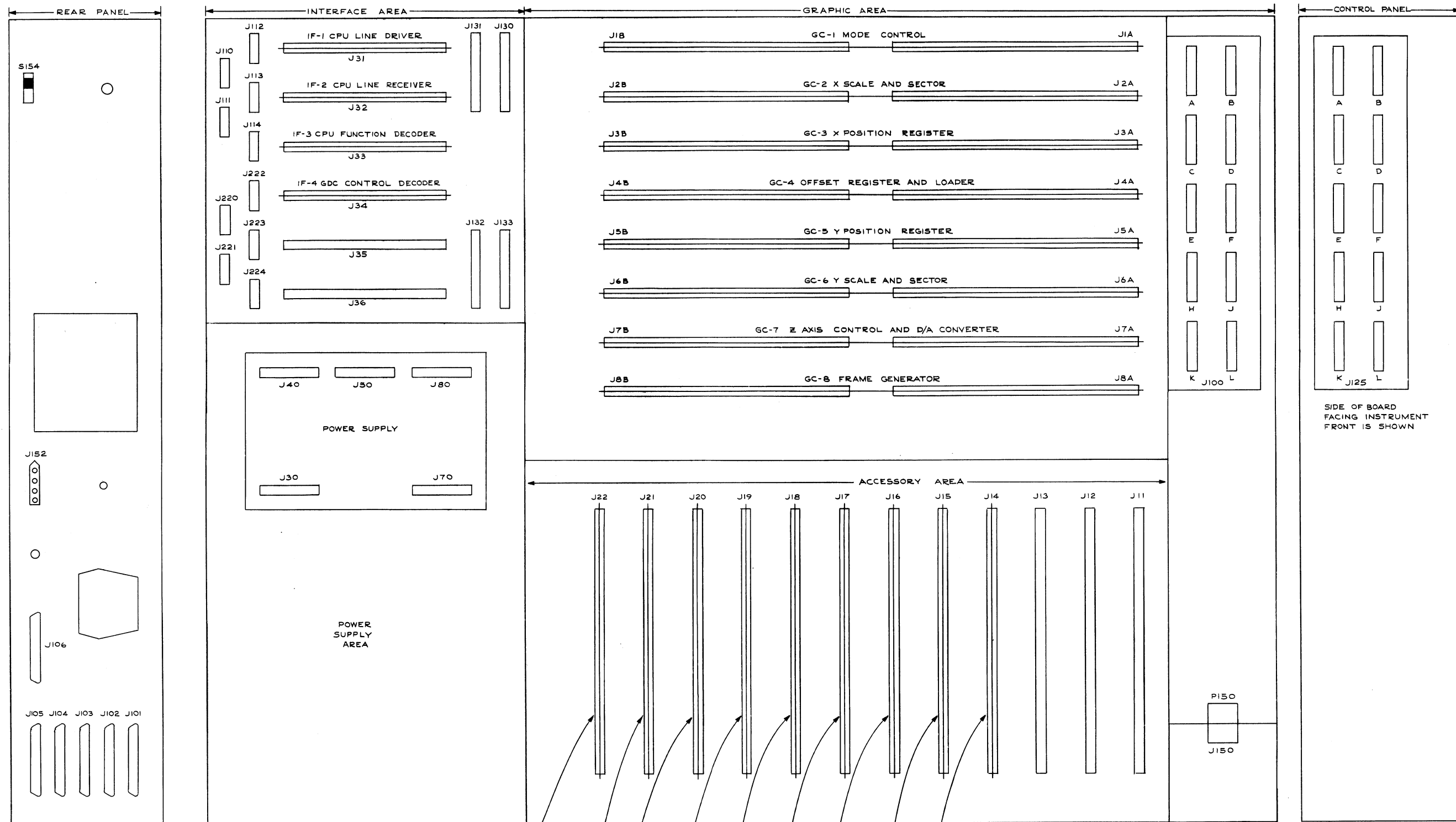
T4005/4201
READY MODE BLOCK DIAGRAM



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T4005/4201
FRAME MODE BLOCK DIAGRAM





ACC-12 GDC STATUS WORD SELECTOR
 ACC-11 GDC STATUS GATE A
 ACC-9, ACC-10 GDC STATUS WORD
 ACC-5, ACC-6, ACC-7, ACC-8 DISPLAY DEVICE
 ACC-4 PARTIAL SOFTWARE CONTROL BOARD

CONTROL UNIT CONNECTORS

WIRE LIST FOR
CONTROL PANEL CONNECTOR J125

Connector and pin	To/From Connectors J and P	Signal Name or Function
J125 A-1	J3A-4 14	RIGHT OFFSET SWITCH
2	J5A-2 17	DOWN OFFSET SWITCH
3	J5A-4 17	UP OFFSET SWITCH
4	J1A-X 2	LOCATE SWITCH
5	J1A-17, J7A-10 24	HOME SWITCH
6	J1A-F 2	FRAME SWITCH
7	J3A-2 14	LEFT OFFSET SWITCH
8	J4-L 29	INT. PEND. LIGHT
9	J1A-C 2	FAST SWITCH
10	J14-23 28	#8 SWITCH
J125 B-1	J2B-2 7	RIGHT OFFSET LIGHT
2	J6B-C 12	DOWN OFFSET LIGHT
3	J6B-2 12	UP OFFSET LIGHT
4	J1A-Y 2	LOCATE LIGHT
5	J7A-17 24	HOME LIGHT
6	J1B-F 2	FRAME LIGHT
7	J2B-C 7	LEFT OFFSET LIGHT
8	J230 33	INT. DISABLED LIGHT
9	J1A-3 2	FAST LIGHT
10	J125F-1	+5 V
J125 C-1	J1A-4 2	READY SWITCH
2	J14-26 28	#7 SWITCH
3	J7A-A 24	ADDRESSED LIGHT
4	J1A-L 2	H SWITCH
5		
6		
7	J1A-12 2	MAN. SWITCH
8	J14-FF 28	#3 SWITCH
9		
10	J14-17 29	F SWITCH

WIRE LIST FOR J125 (cont)

Connector and pin	To/From Connectors J and P	Signal Name or Function
J125 D-1	J1B-E 2	READY LIGHT
2	J14-24 28	#6 SWITCH
3	J230 32	PROCESSOR RUNNING LIGHT
4	J14-D 28	H LIGHT
5	J14-X 29	G SWITCH
6	J14-E 28	G LIGHT
7	J14-21 28	#5 SWITCH
8	J14-28 28	#4 SWITCH
9	J14-EE 28	#2 SWITCH
10	J14-5 28	F LIGHT
J125 E-1	J14-CC 29	E SWITCH
2	J14-16 29	D SWITCH
3	J1A-CC 2	VERT. AUG. SWITCH
4		
5		
6	J1B-B 2	HORIZ. AUG. LIGHT
7	J1A-D 2	AUTO SWITCH
8	J6A-28 9	Y256 SWITCH
9	J2A-28 4	X256 SWITCH
10	J18-19 30	DEVICE IV SWITCH
J125 F-1	J125 J1, J125B-10	+5 V
2	J14-4 28	E LIGHT
3	J14-H 28	D LIGHT
4	J1B-D 2	VERT. AUG. LIGHT
5	J14-DD 28	#1 SWITCH
6	J1A-25 2	HORIZ. AUG. SWITCH
7	J1A-9 2	AUTO ERASE LIGHT
8	J6A-M 9	VERT. 256 LIGHT
9	J2A-M 4	HORIZ. 256 LIGHT
10	J18-W 30	DEVICE IV LIGHT

WIRE LIST FOR J125

Connector and pin	To/From Connectors J and P	
J125 H-1	COMMON	GROU
2	J14-BB 29	C SWIT
3	J17-19 30	DEVIC
4	J1B-9 2	RECA
5	J2A-25 4	X512
6	J14-Z 29	B SWIT
7	J2A-CC 4	X 1K
8	J6A-P 9	Y 512
9	J16-W 30	DEVIC
10	J14-6 28	A LIG
J125 J-1	J125 F1, +5 Source	+5 V
2	J14-F 28	C LIG
3	J17-W 30	DEVIC
4		
5	J2A-P 4	X 512
6	J14-J 28	B LIG
7	J2A-13 4	X 1K
8	J6A-25 9	Y 512
9	J16-19 30	DEVIC
10	J14-AA 29	A SWIT
J125 K-1	J6A-13 9	Y 1K
2	J15-W 30	DEVIC
3	J6A-L 9	Y 2K
4	J2A-L 4	X 2K
5	J7A-22 23	OFF L
6	J6A-12 9	Y 4K
7	J6A-10 9	Y 8K
8	J2A-12 4	X 4K
9	J2A-10 4	X 8K
10	J7A-Z 24	RETA

WIRE LIST FOR J125 (cont)

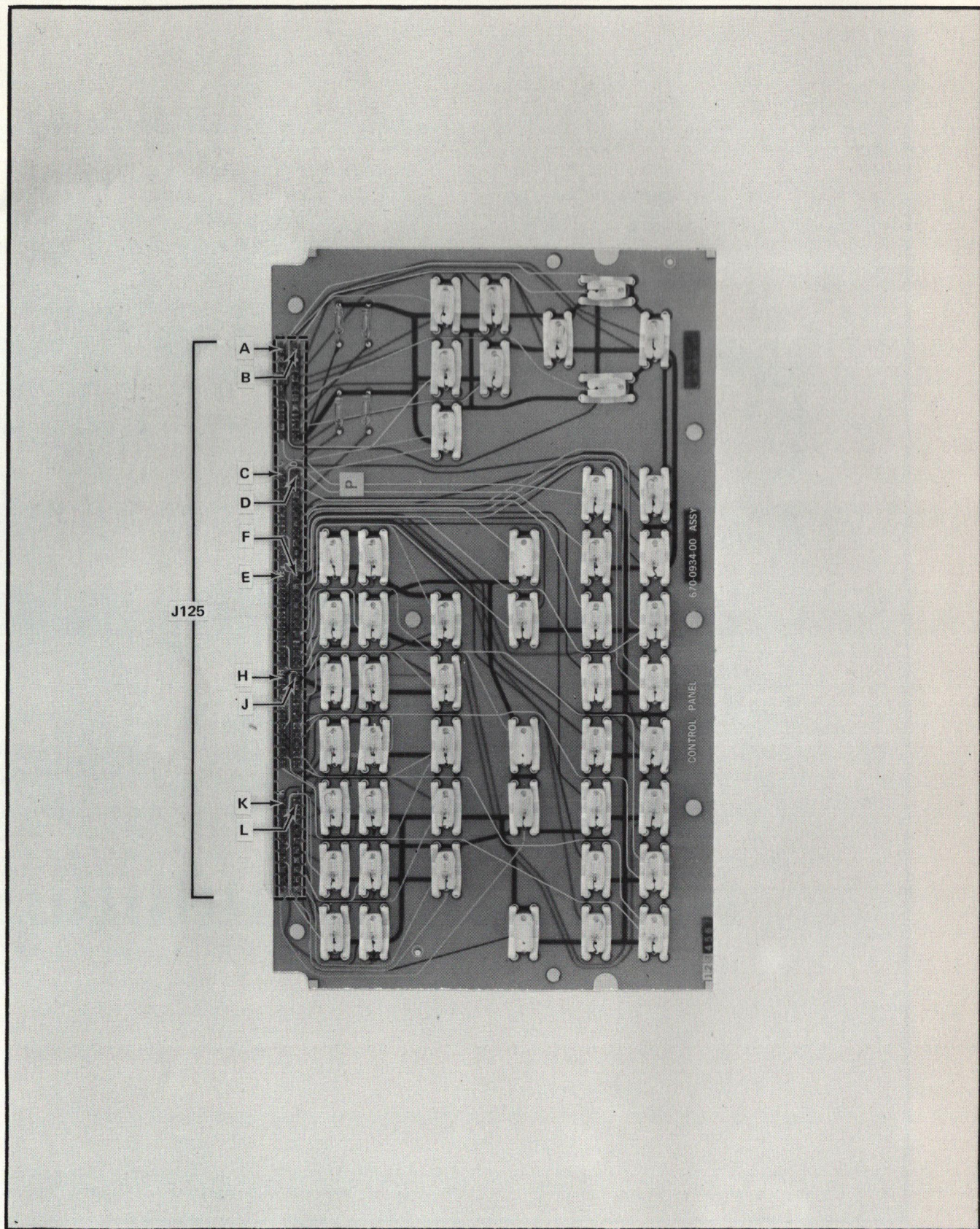
Connector and pin	To/From Connectors J and P	Signal Name or Function
J125 D-1	J1B-E 2	READY LIGHT
2	J14-24 28	#6 SWITCH
3	J230 32	PROCESSOR RUNNING LIGHT
4	J14-D 28	H LIGHT
5	J14-X 29	G SWITCH
6	J14-E 28	G LIGHT
7	J14-21 28	#5 SWITCH
8	J14-28 28	#4 SWITCH
9	J14-EE 28	#2 SWITCH
10	J14-5 28	F LIGHT
J125 E-1		
2	J14-CC 29	E SWITCH
3	J14-16 29	D SWITCH
4	J1A-CC 2	VERT. AUG. SWITCH
5		
6	J1B-B 2	HORIZ. AUG. LIGHT
7	J1A-D 2	AUTO SWITCH
8	J6A-28 9	Y256 SWITCH
9	J2A-28 4	X256 SWITCH
10	J18-19 30	DEVICE IV SWITCH
J125 F-1	J125 J1, J125B-10	+5 V
2	J14-4 28	E LIGHT
3	J14-H 28	D LIGHT
4	J1B-D 2	VERT. AUG. LIGHT
5	J14-DD 28	#1 SWITCH
6	J1A-25 2	HORIZ. AUG. SWITCH
7	J1A-9 2	AUTO ERASE LIGHT
8	J6A-M 9	VERT. 256 LIGHT
9	J2A-M 4	HORIZ. 256 LIGHT
10	J18-W 30	DEVICE IV LIGHT

WIRE LIST FOR J125 (cont)

Connector and pin	To/From Connectors J and P	Signal Name or Function
J125 H-1	COMMON	GROUND
2	J14-BB 29	C SWITCH
3	J17-19 30	DEVICE III SWITCH
4	J1B-9 2	RECALL SWITCH
5	J2A-25 4	X512 SWITCH
6	J14-Z 29	B SWITCH
7	J2A-CC 4	X 1K SWITCH
8	J6A-P 9	Y 512 LIGHT
9	J16-W 30	DEVICE II LIGHT
10	J14-6 28	A LIGHT
J125 J-1	J125 F1, +5 Source	+5 V
2	J14-F 28	C LIGHT
3	J17-W 30	DEVICE III LIGHT
4		
5	J2A-P 4	X 512 LIGHT
6	J14-J 28	B LIGHT
7	J2A-13 4	X 1K LIGHT
8	J6A-25 9	Y 512 SWITCH
9	J16-19 30	DEVICE II SWITCH
10	J14-AA 29	A SWITCH
J125 K-1	J6A-13 9	Y 1K LIGHT
2	J15-W 30	DEVICE I LIGHT
3	J6A-L 9	Y 2K LIGHT
4	J2A-L 4	X 2K LIGHT
5	J7A-22 23	OFF LIGHT
6	J6A-12 9	Y 4K LIGHT
7	J6A-10 9	Y 8K LIGHT
8	J2A-12 4	X 4K LIGHT
9	J2A-10 4	X 8K LIGHT
10	J7A-Z 24	RETAIN SWITCH

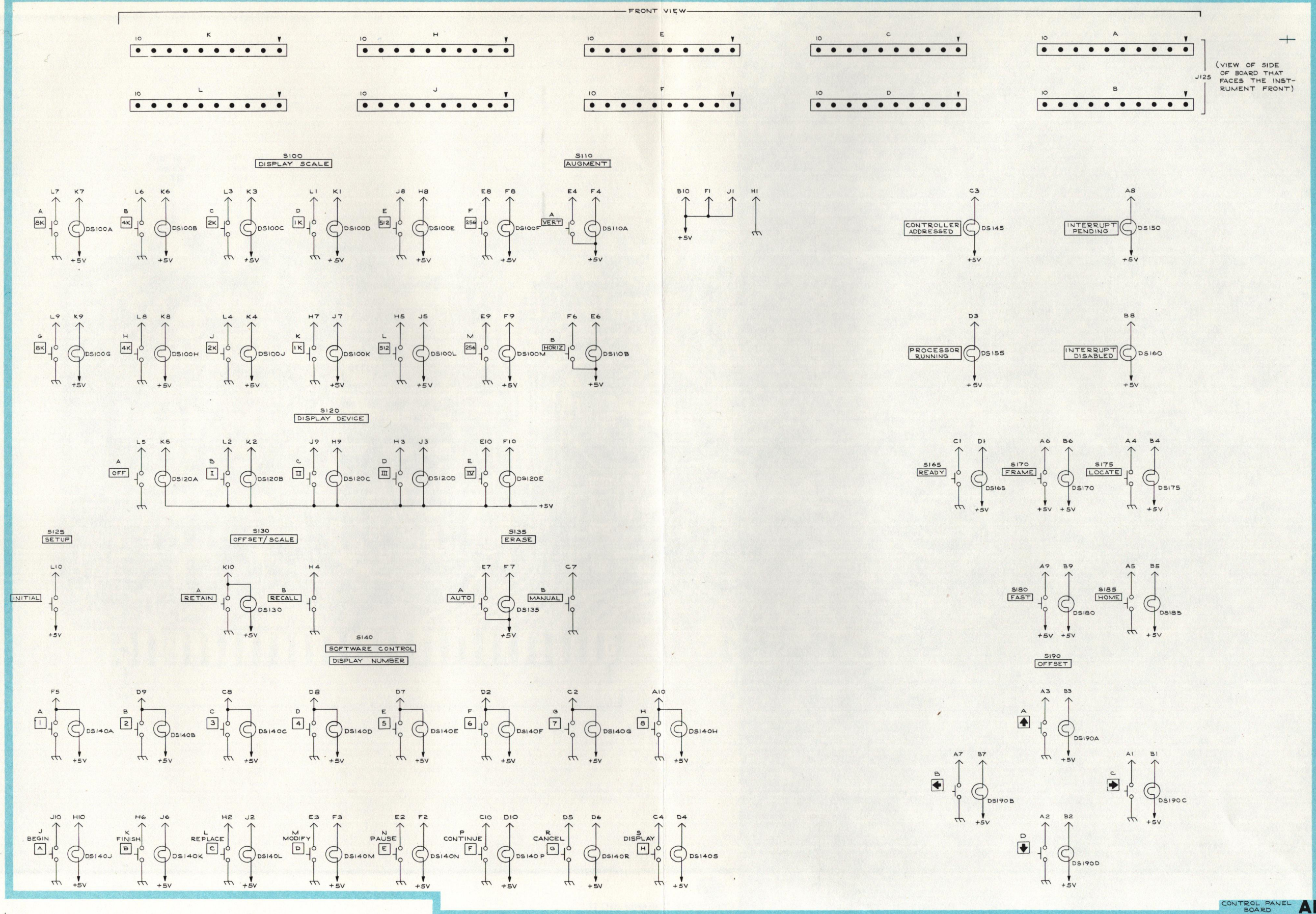
WIRE LIST FOR J125 (cont)

Connector and pin	To/From Connectors J and P	Signal Name or Function
J125 L-1	J6A-CC 9	Y 1K SWITCH
2	J15-19 30	DEVICE I SWITCH
3	J6A-X 9	Y 2K SWITCH
4	J2A-X 4	X 2K SWITCH
5	J15, 16, 17, 18-V 30	OFF SWITCH
6	J6A-20 9	Y 4K SWITCH
7	J6A-23 9	Y 8K SWITCH
8	J2A-20 4	X 4K SWITCH
9	J2A-23 4	X 8K SWITCH
10	J1A-19 2	INITIAL SWITCH



A 1 Control Panel.

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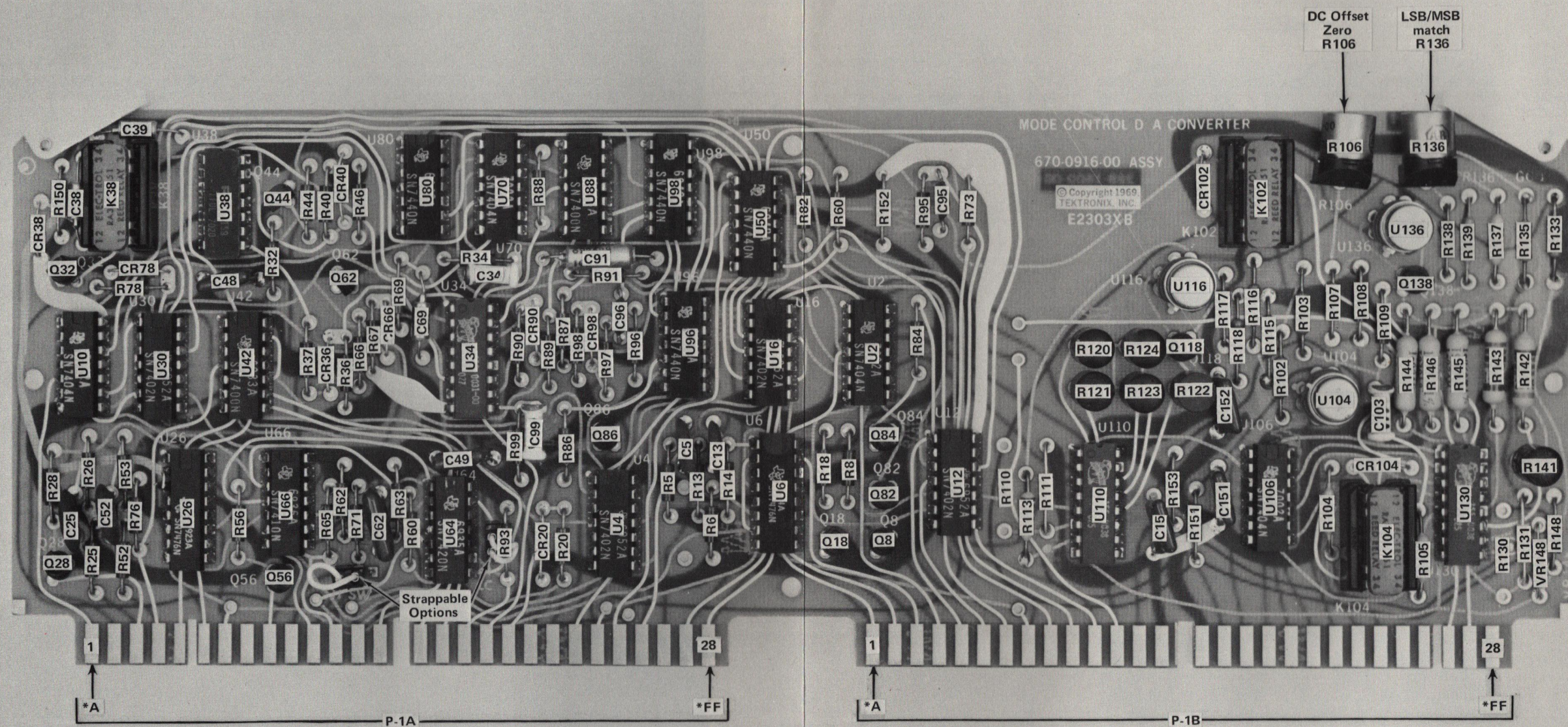


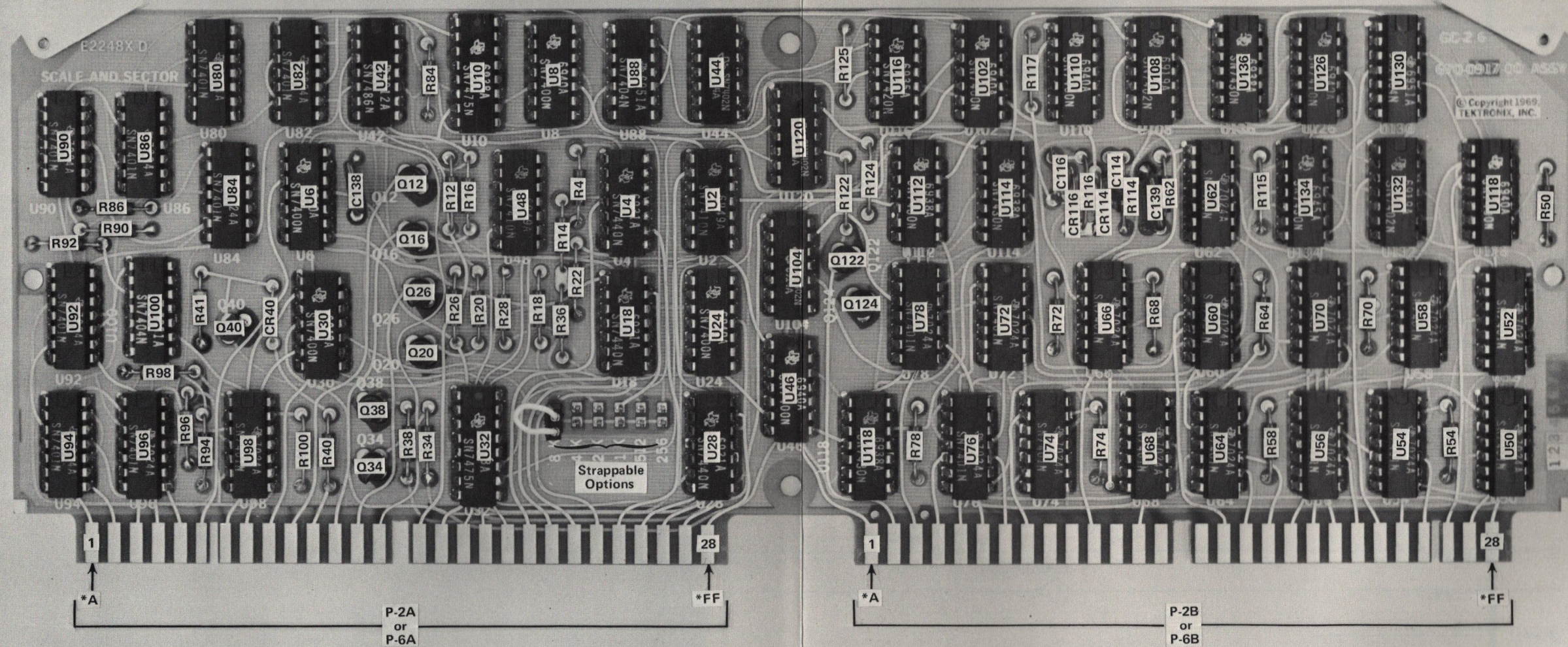
NOTE
* SEE WIRE LIST FOR
J100 AND J125 ON BACK
OF PRECEEDING DIAGRAM

T 4005

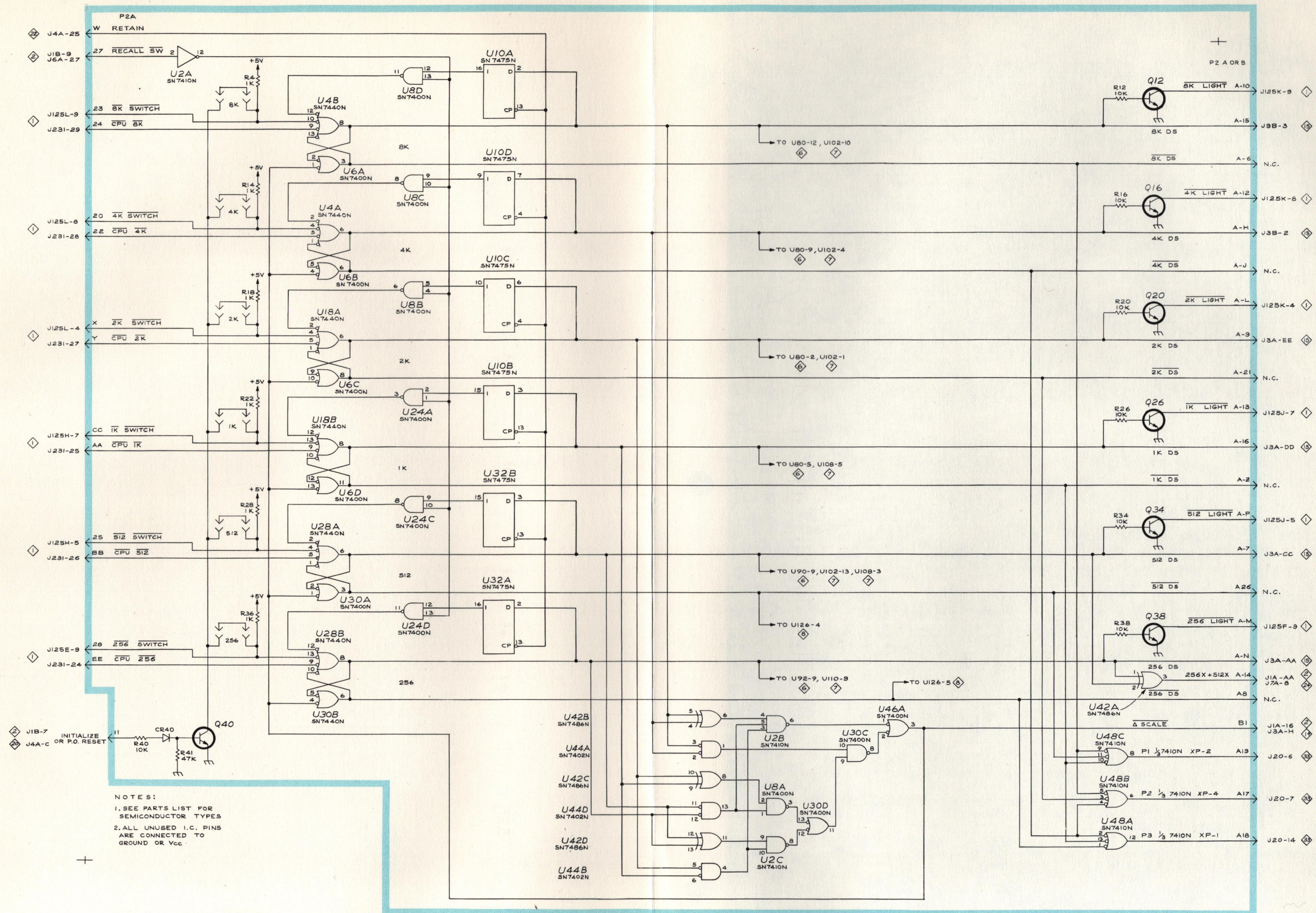
4201 CONTROL PANEL 1170 VR5

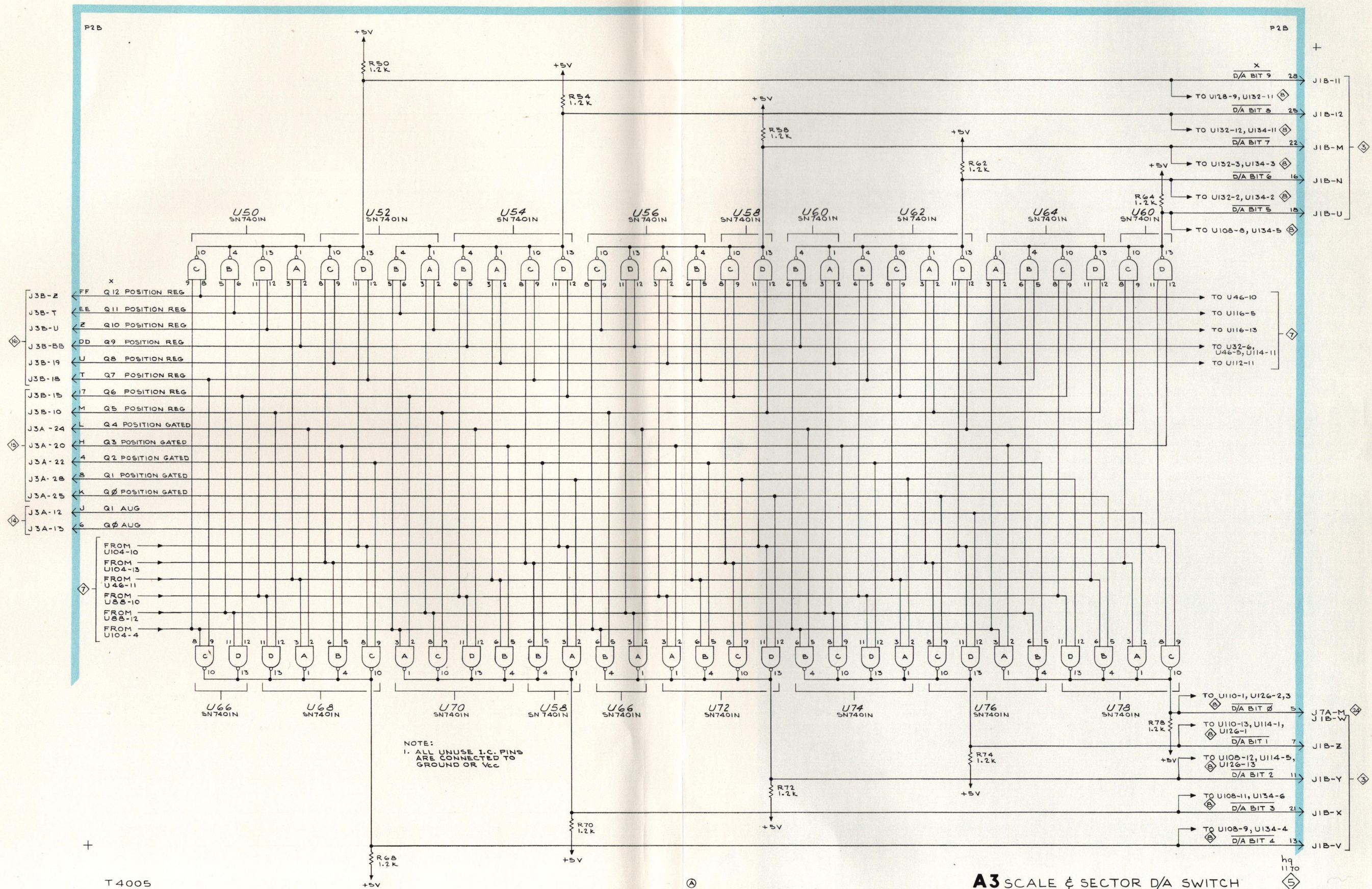
CONTROL PANEL BOARD AI



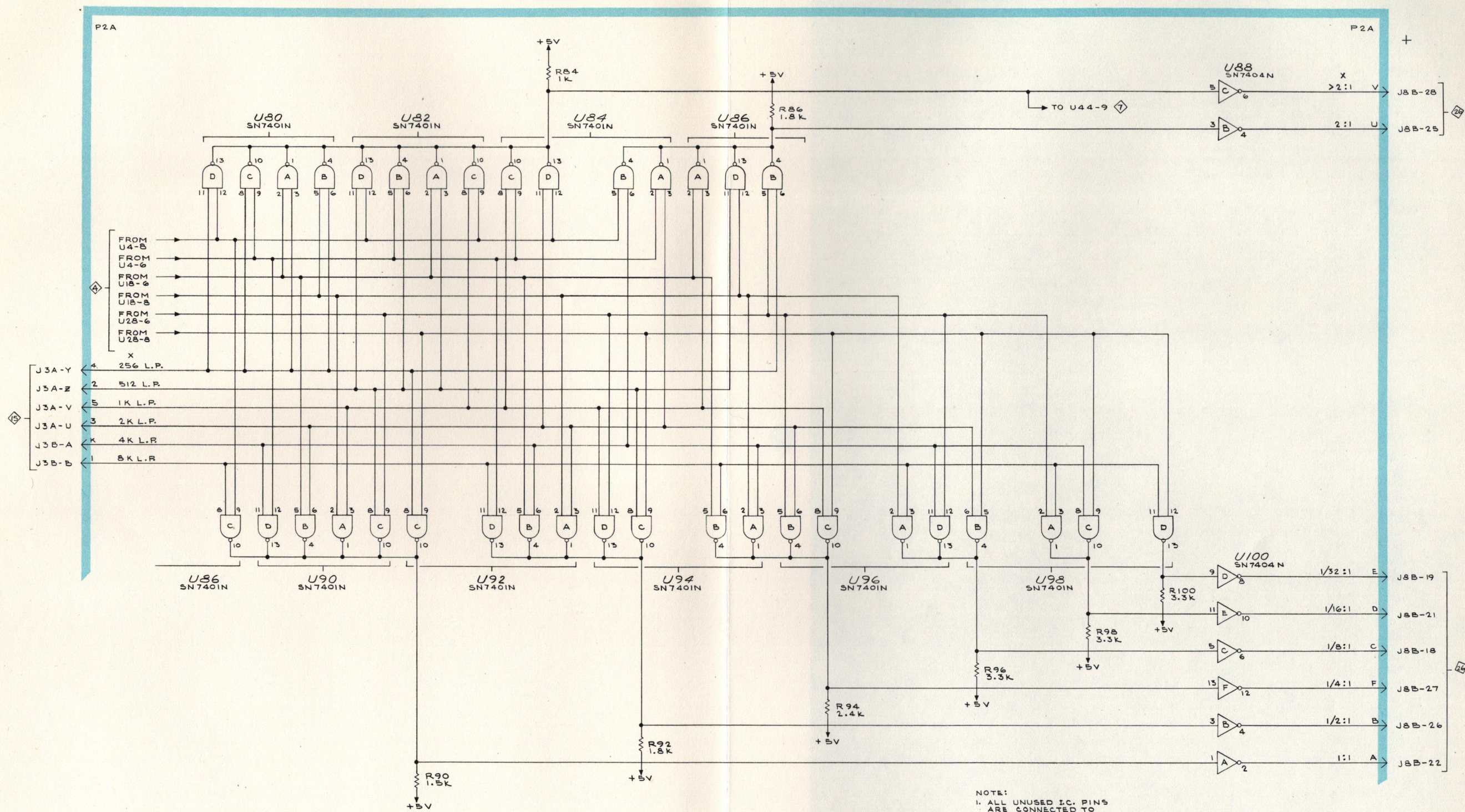


*Contacts on underside are identified by letters.
Letters G, I, O, and Q are not used for identification.





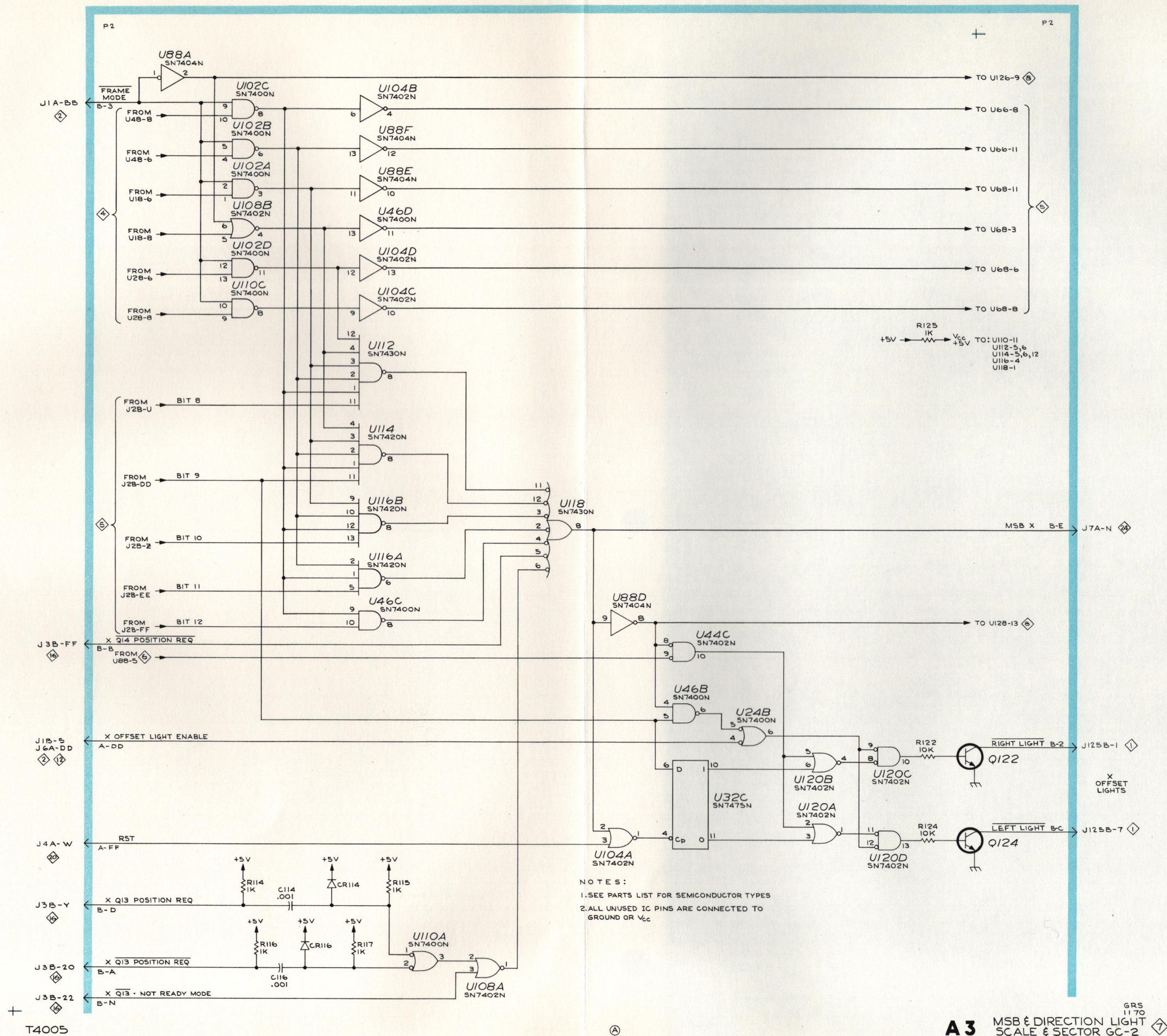
A3 SCALE & SECTOR D/A SWITCH
GC-2



NOTE:
1. ALL UNUSED I.C. PINS
ARE CONNECTED TO
GROUND OR Vcc

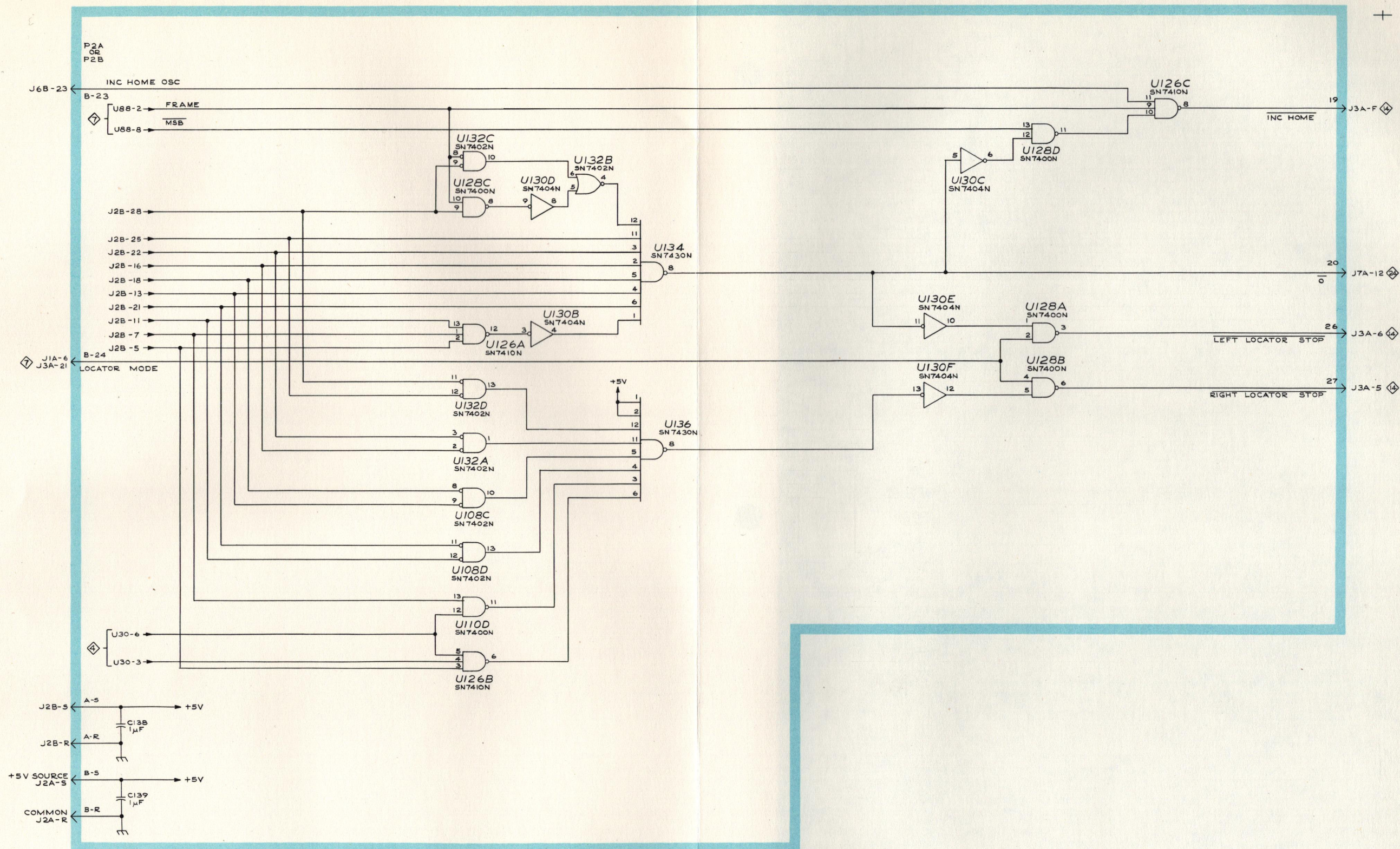
A3 SCALE & SECTOR FRAME SIZE
GC-2

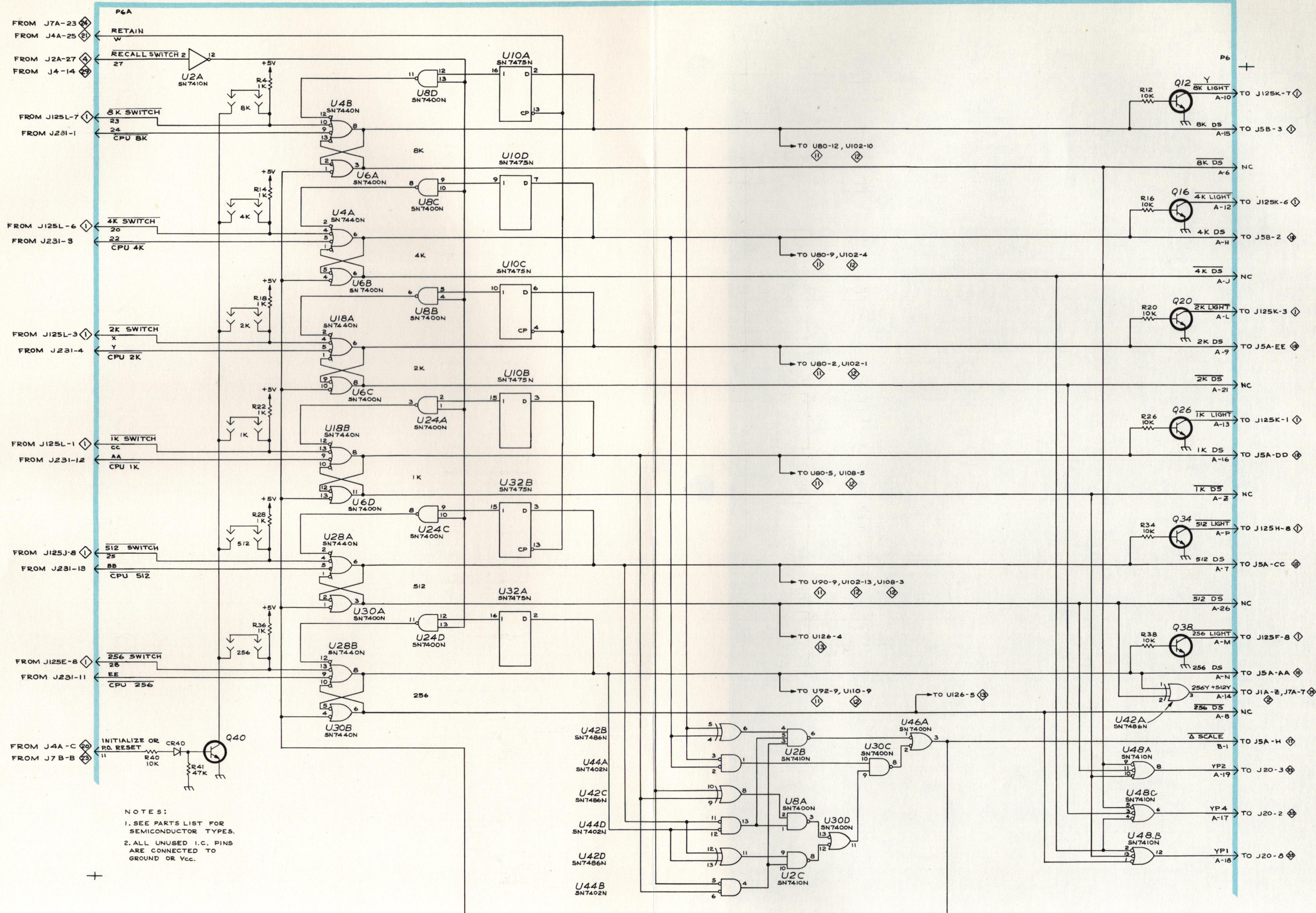
hq
1170

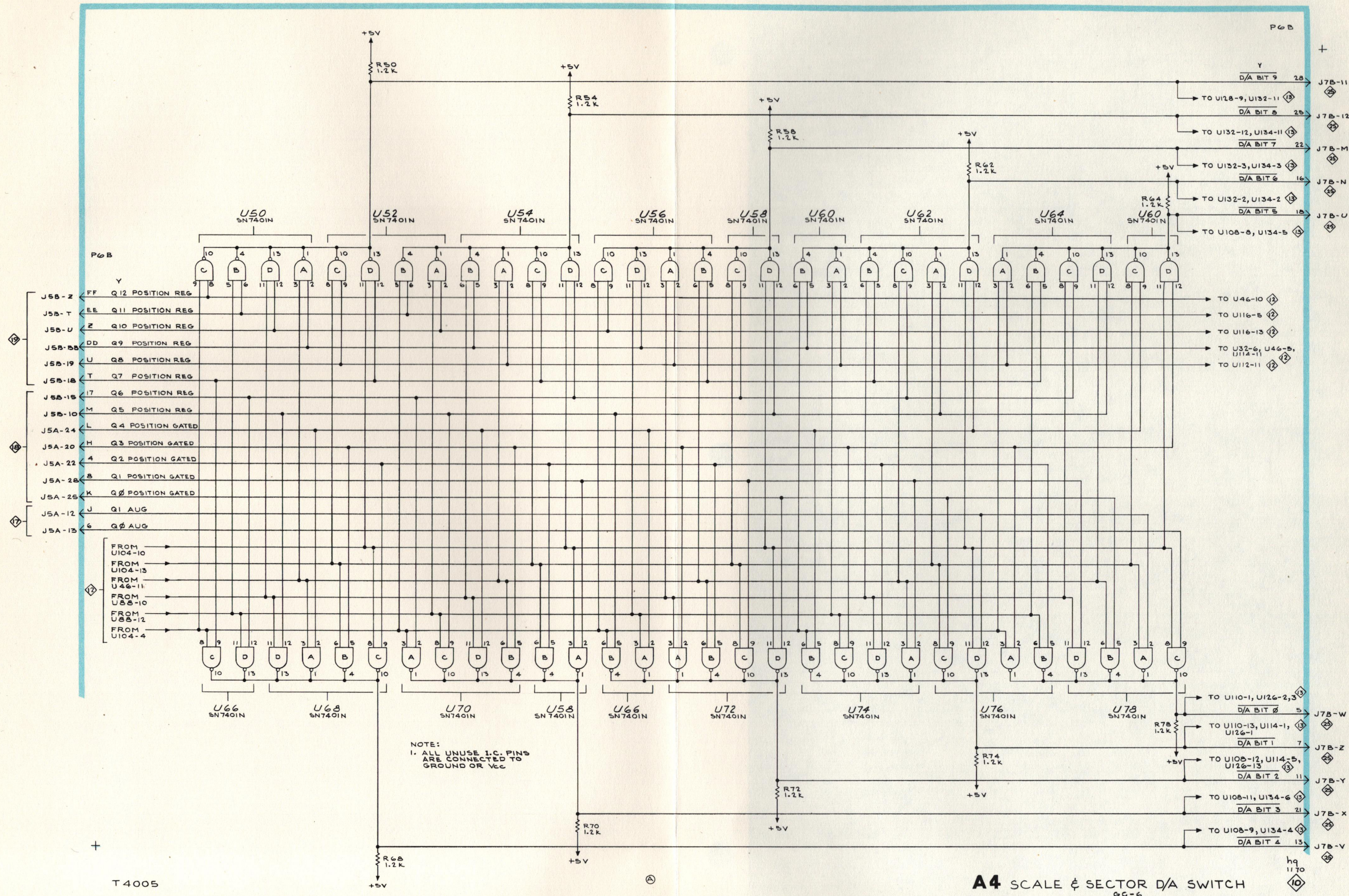


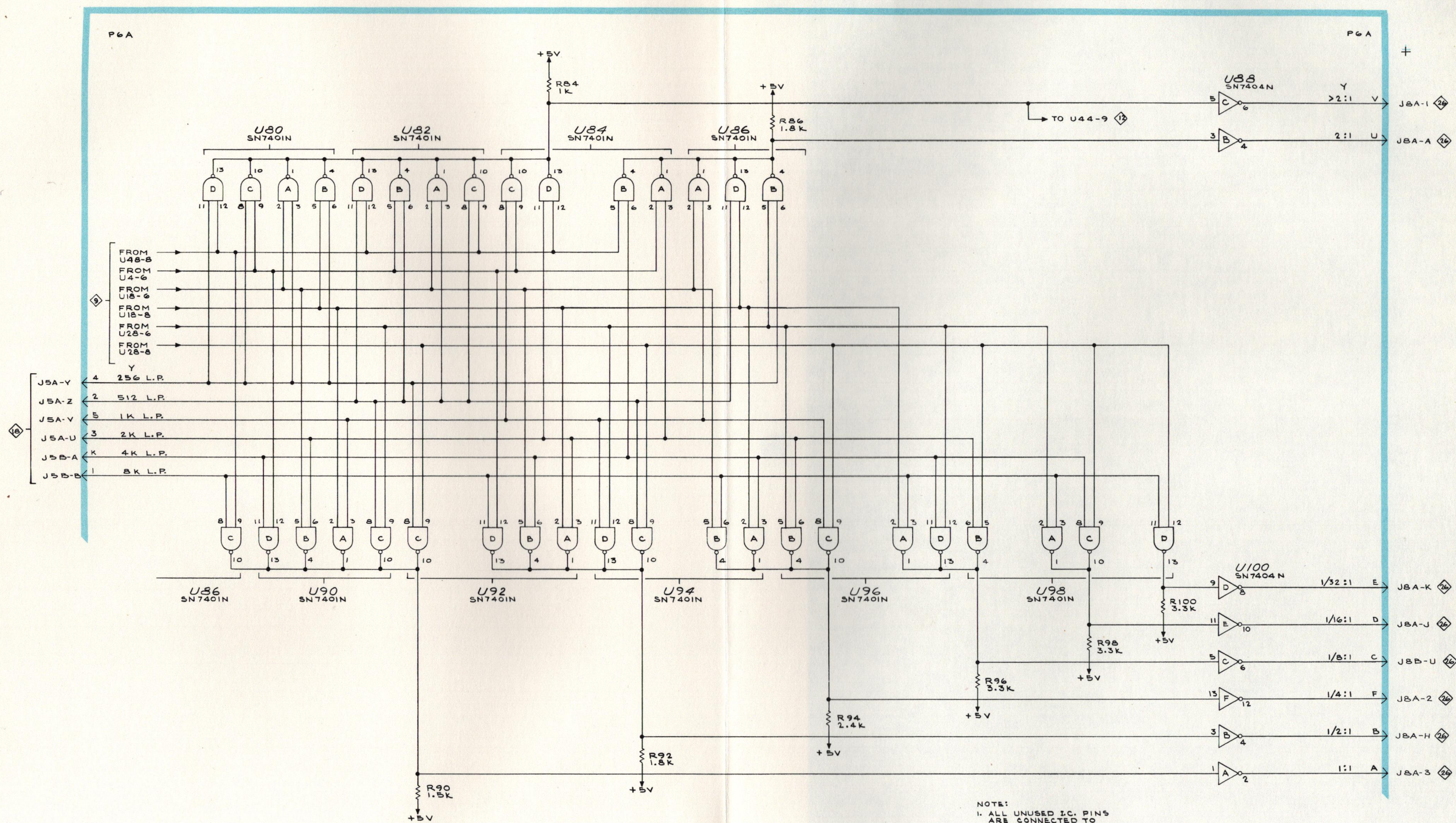
T4005

A3 MSB & DIRECTION LIGHT
SCALE & SECTOR GC-2



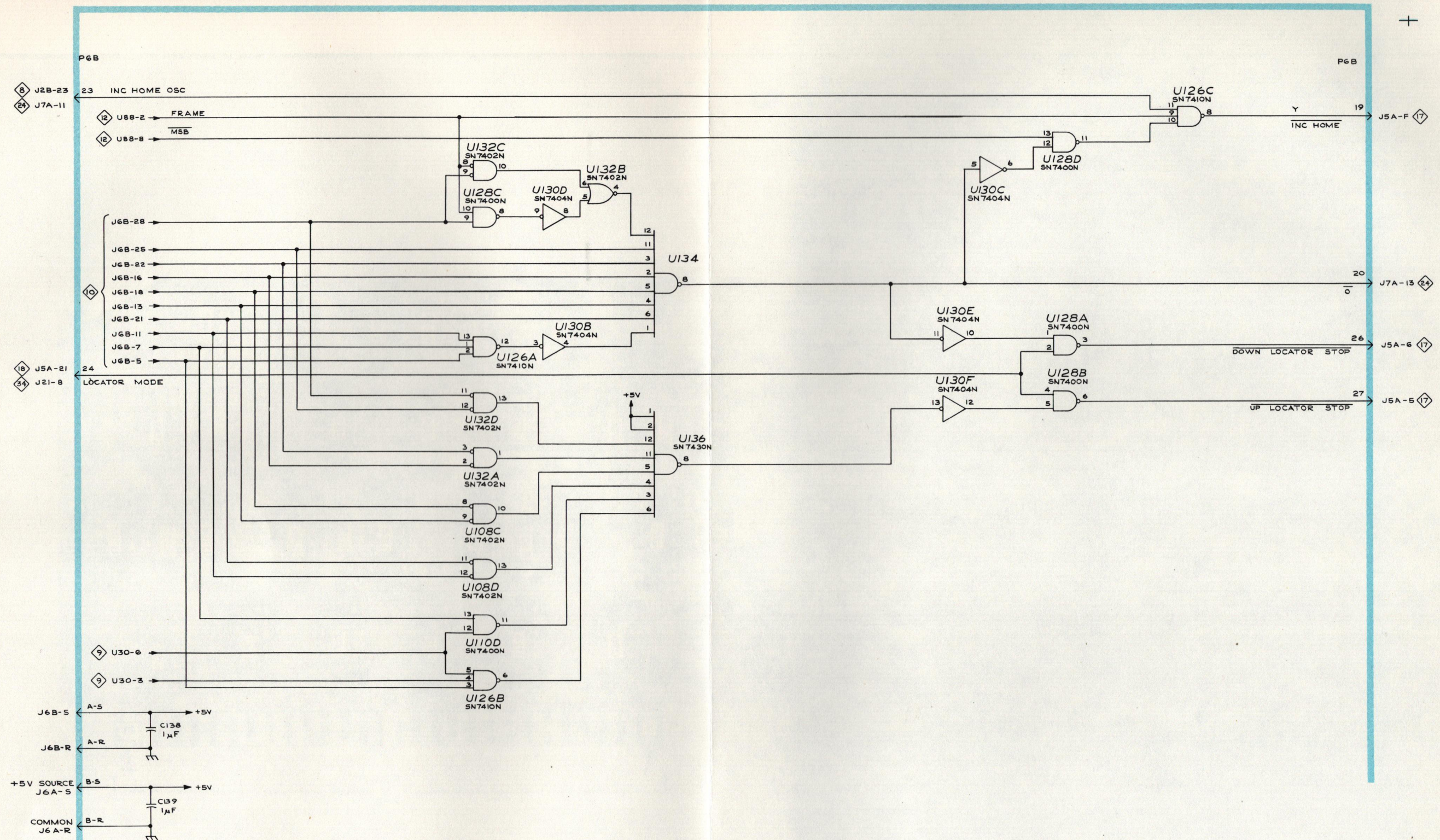




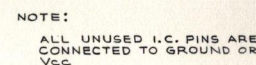


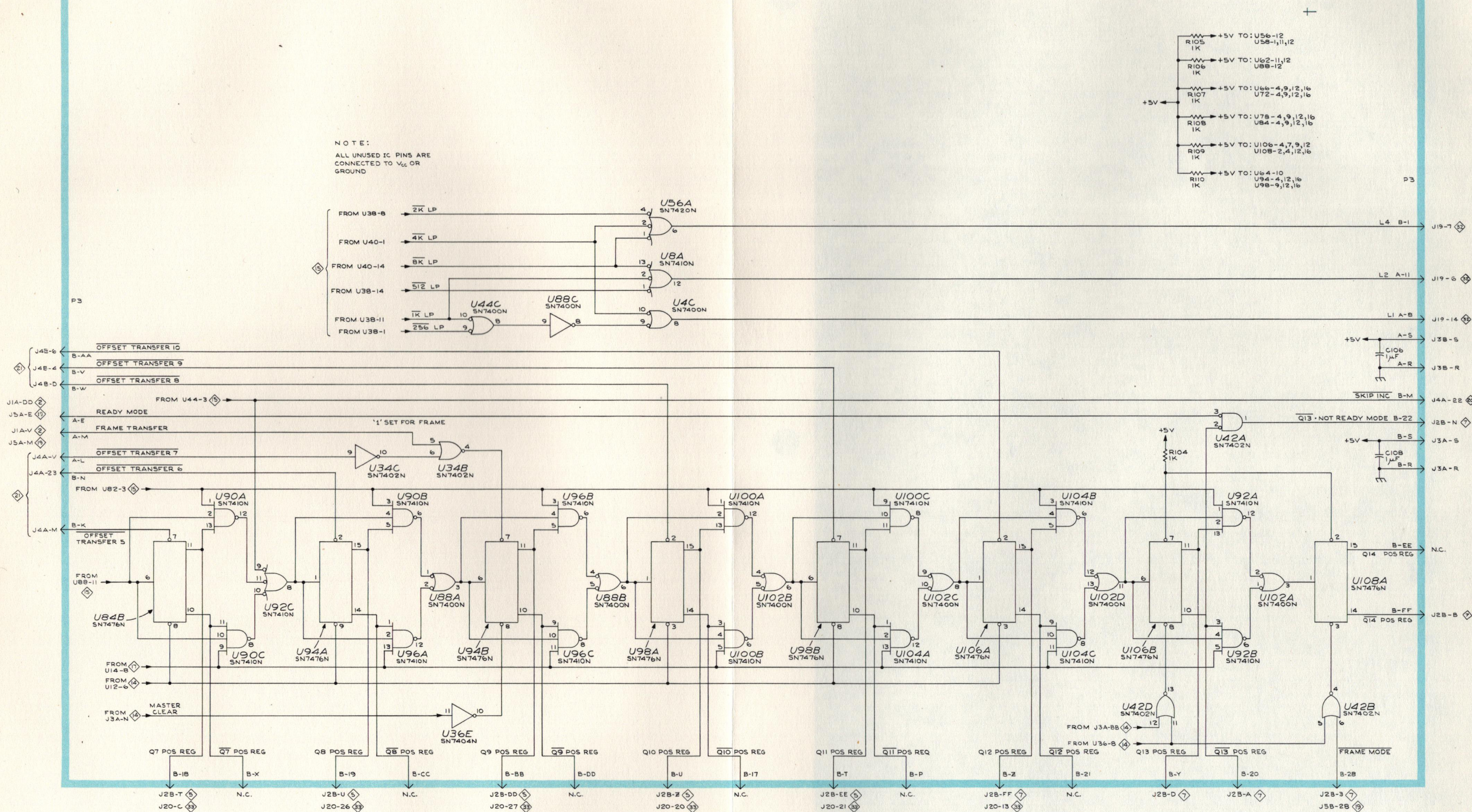
T 4005

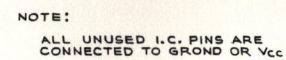
A4 SCALE & SECTOR FRAME SIZE
GC-6hq
1170
11

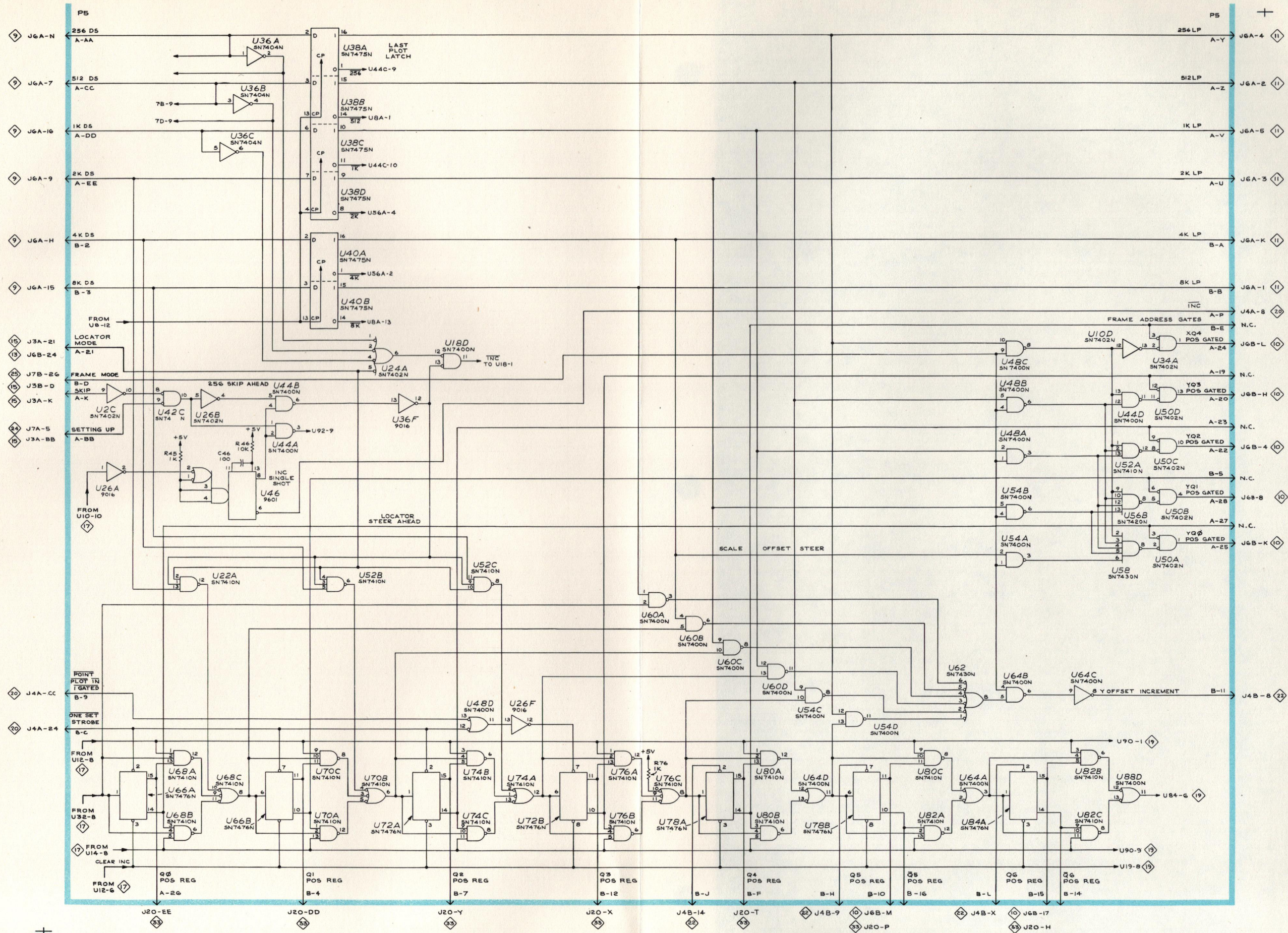


NOTE:
ALL UNUSED I.C. PINS
ARE CONNECTED TO
GROUND OR Vcc.

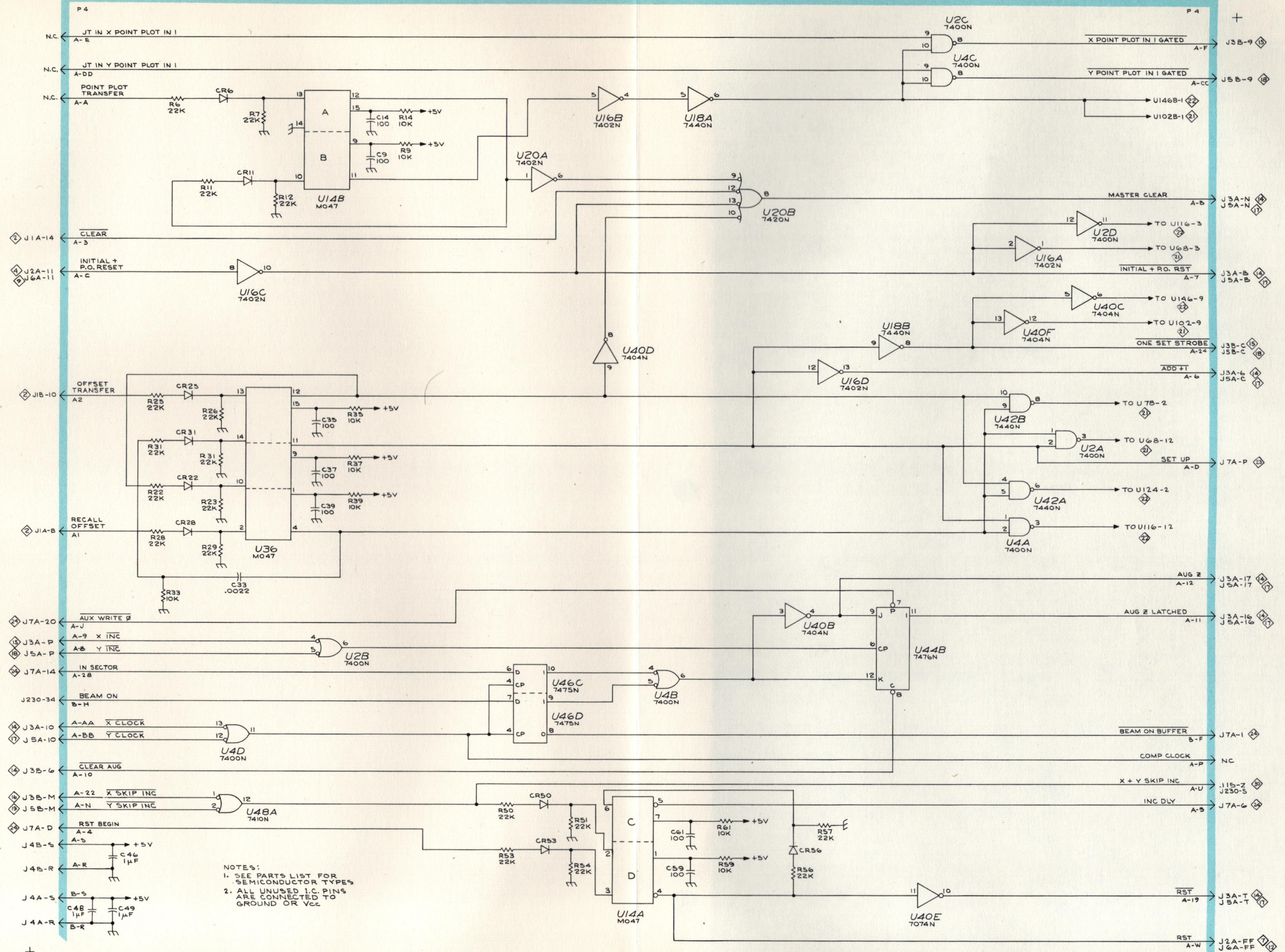




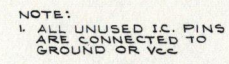


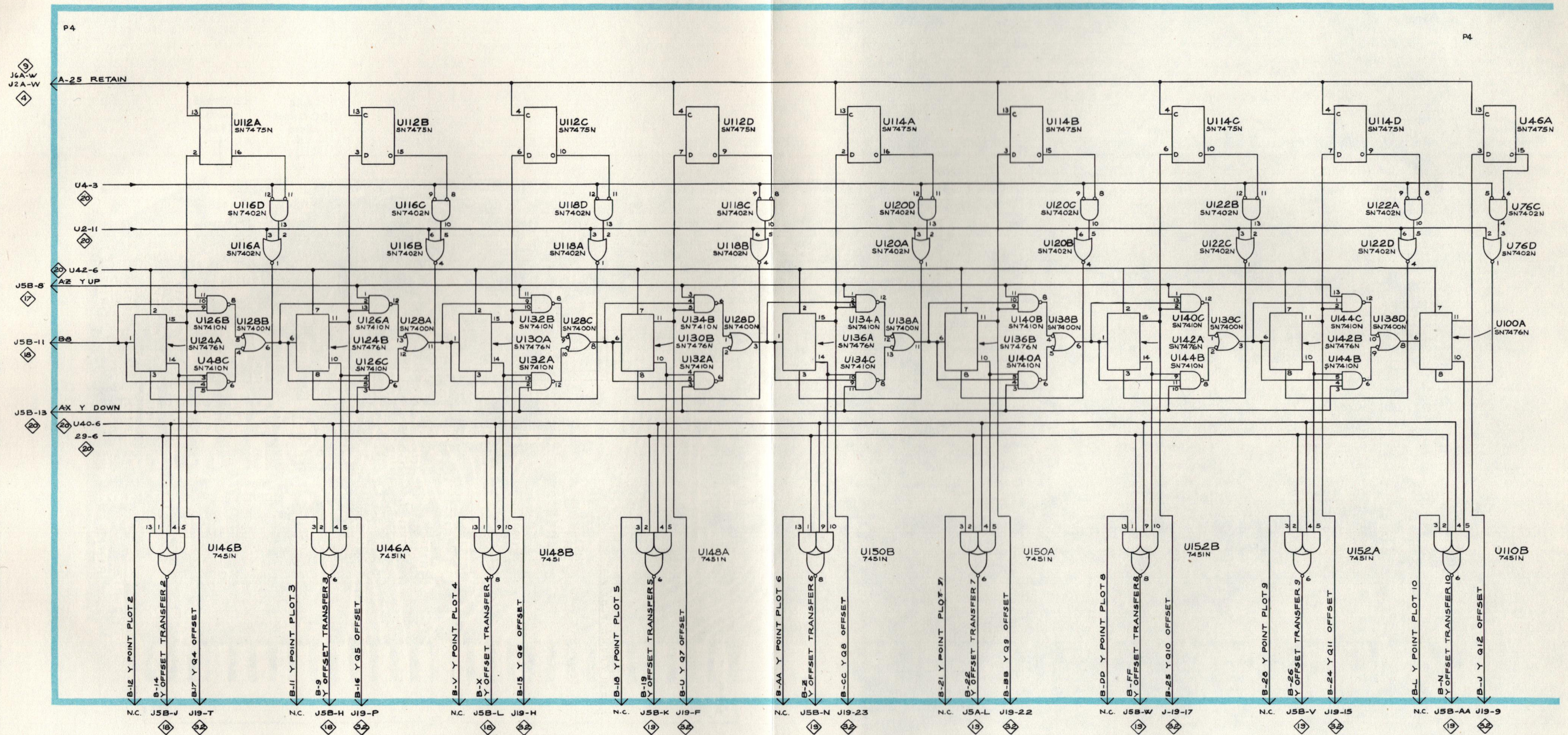






NOTES:
 1. SEE PARTS LIST FOR SEMICONDUCTOR TYPES
 2. ALL UNUSED I.C. PINS ARE CONNECTED TO GROUND OR Vcc

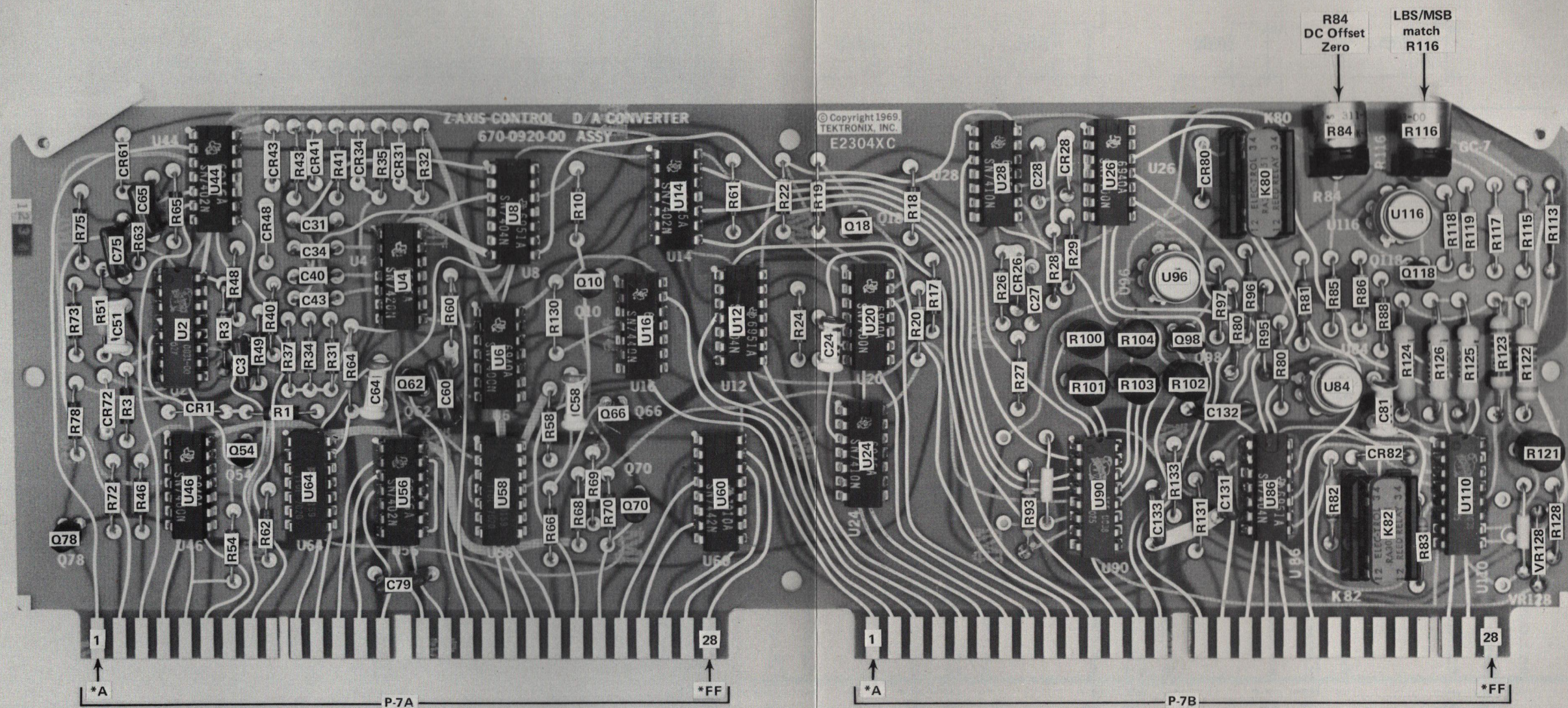




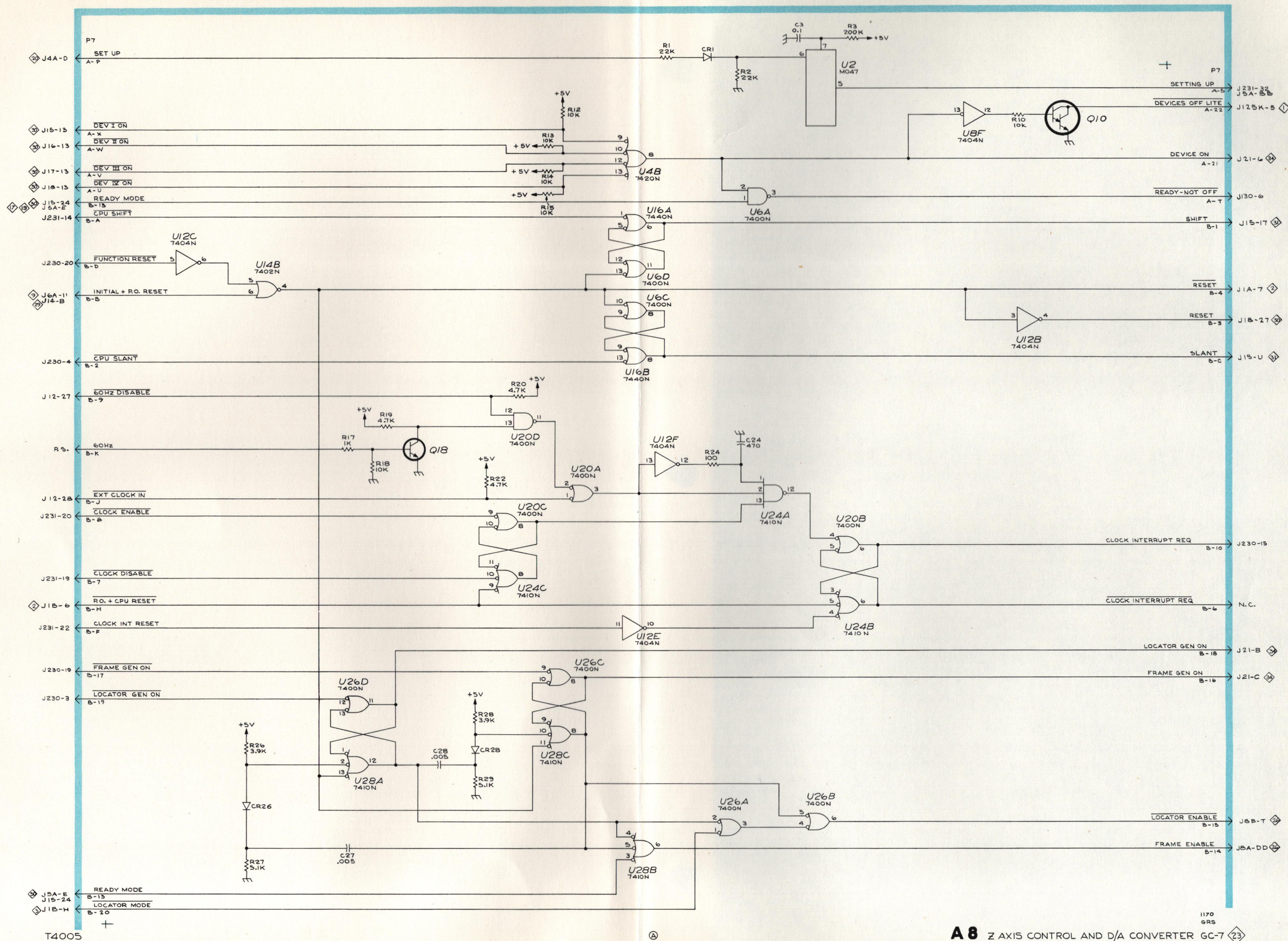
NOTE:
ALL UNUSED I.C. PINS ARE
CONNECTED TO GROUND
OR V_{cc}

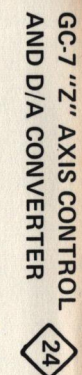
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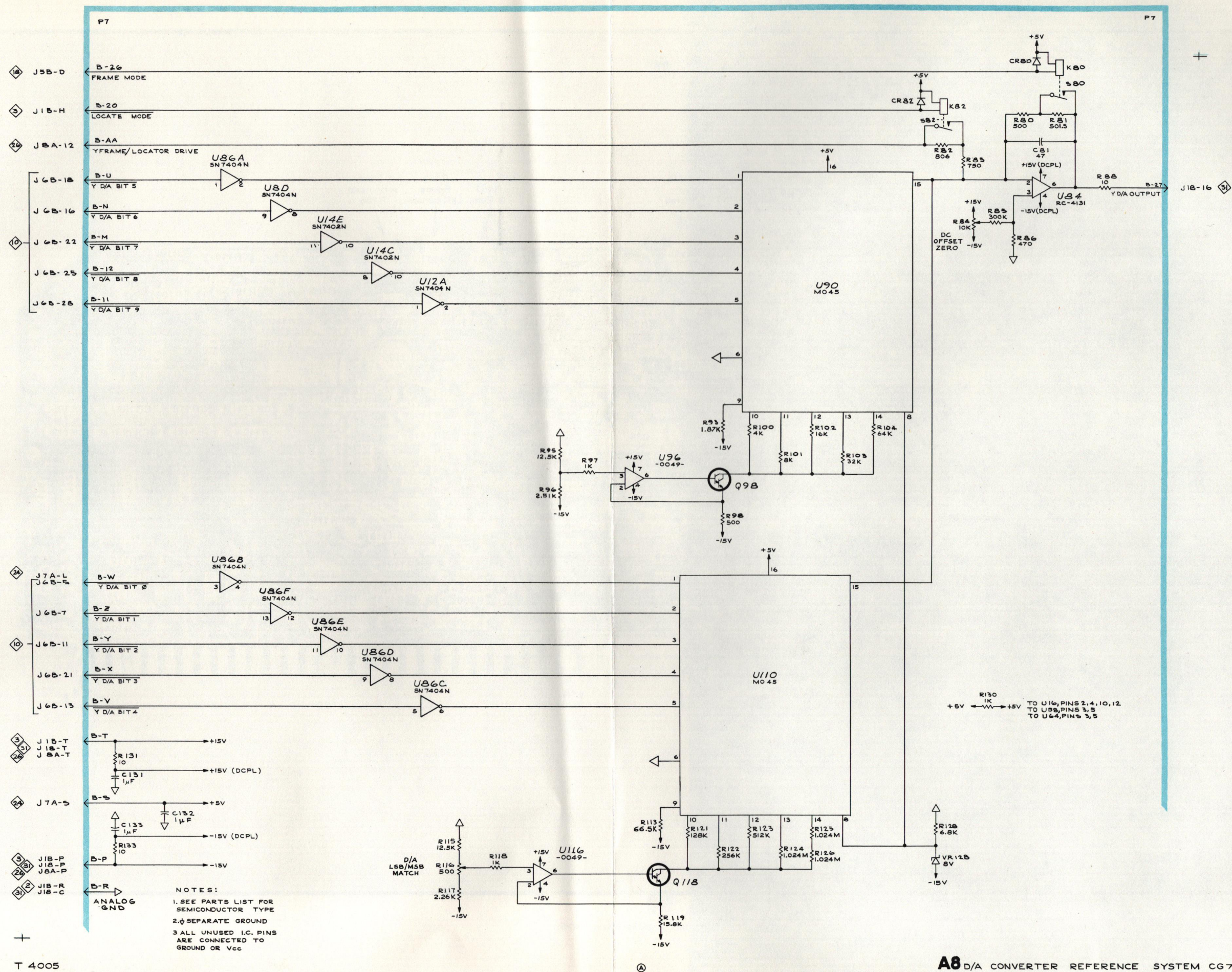
A7 Y OFFSET REGISTER AND LOADER GC4 1170 165

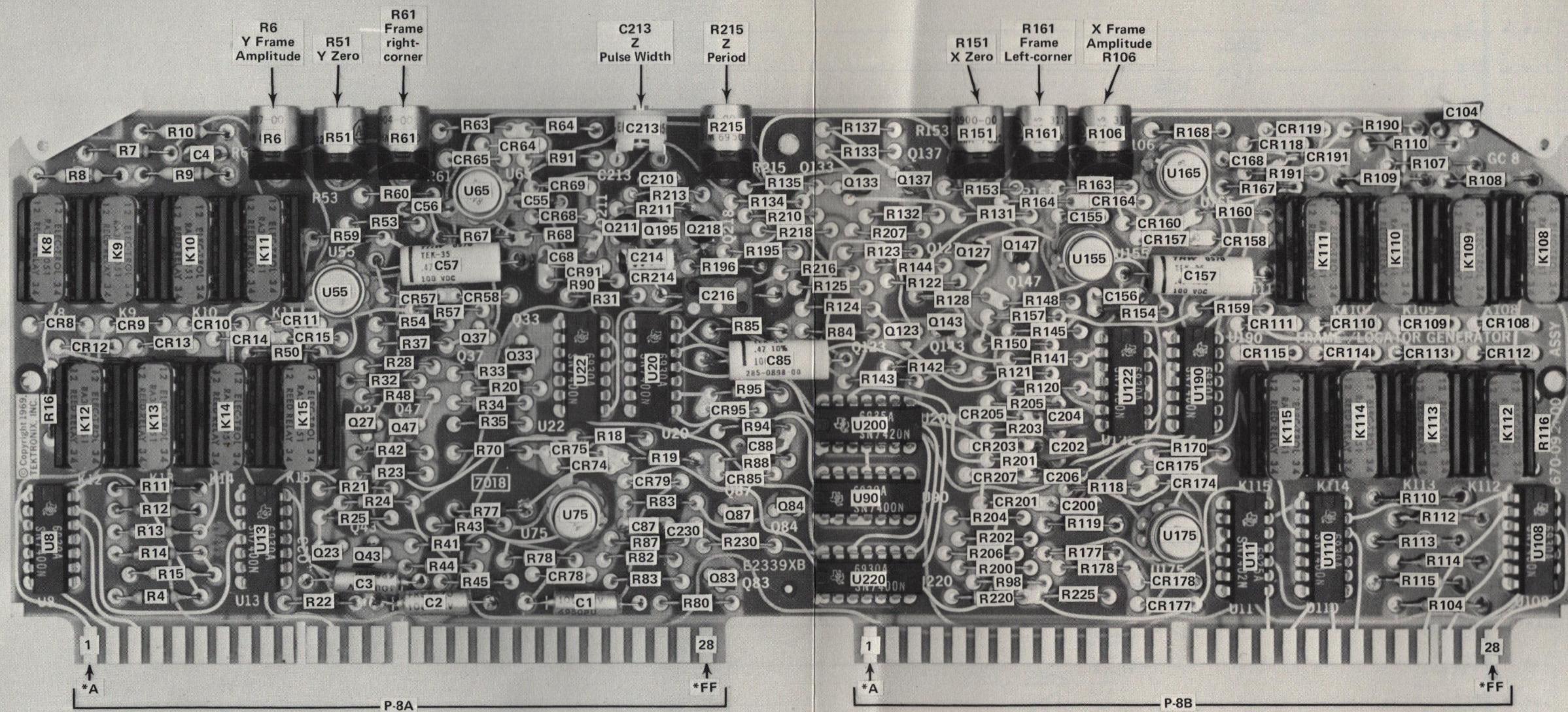


*Contacts on underside are identified by letters.
Letters G, I, O, and Q are not used for identification.

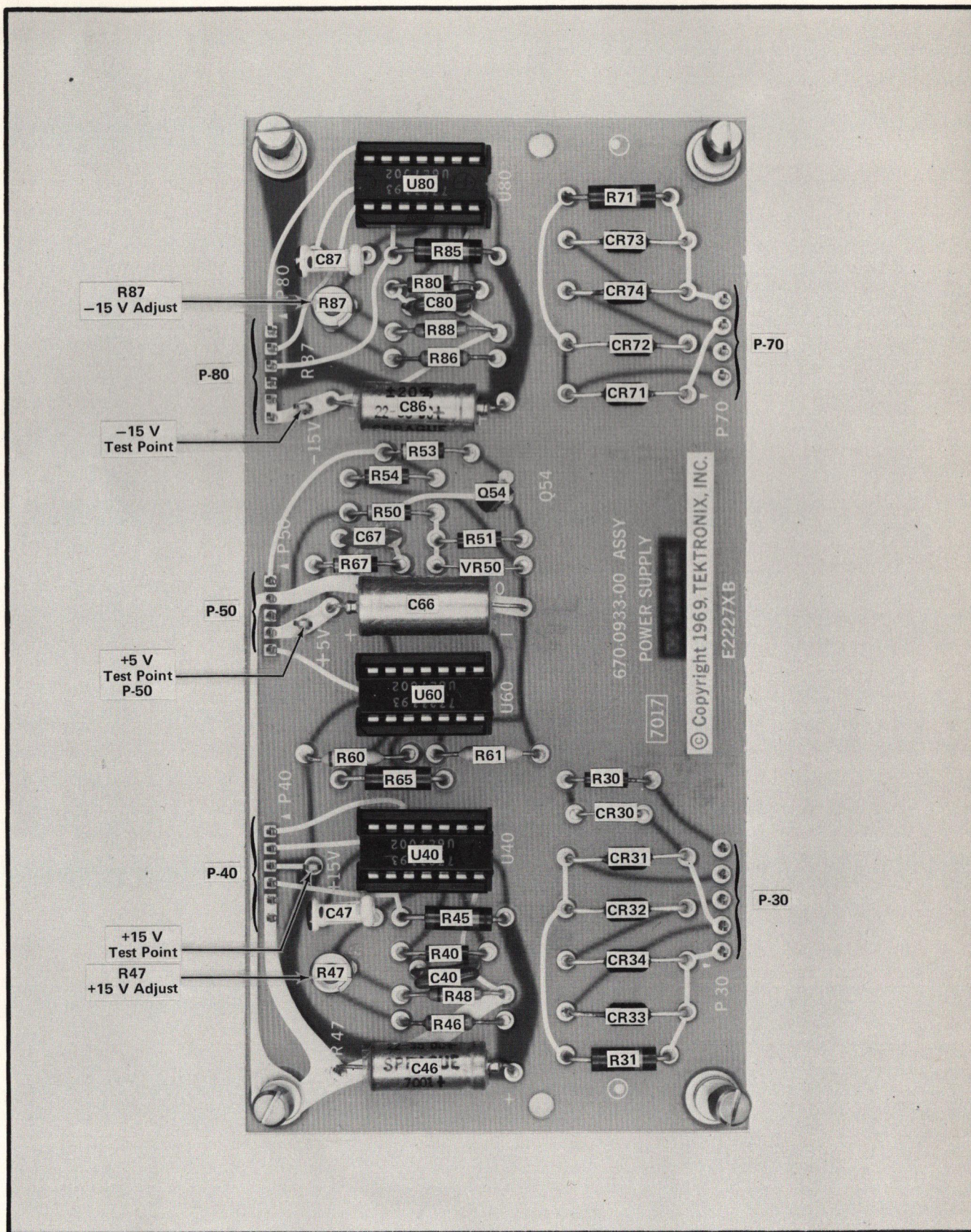




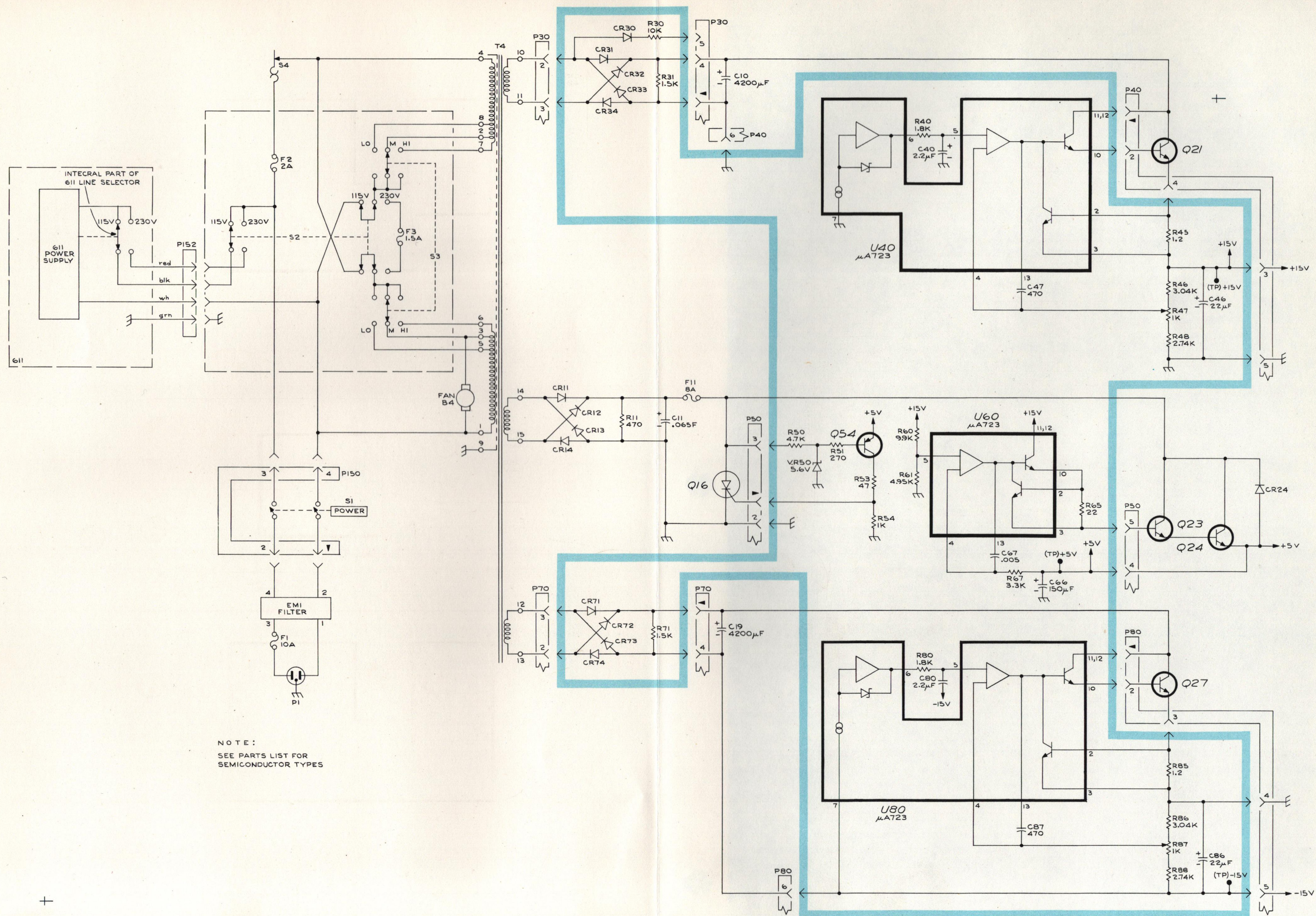




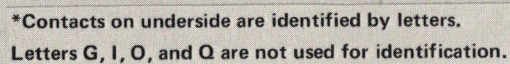
*Contacts on underside are identified by letters.
Letters G, I, O, and Q are not used for identification.

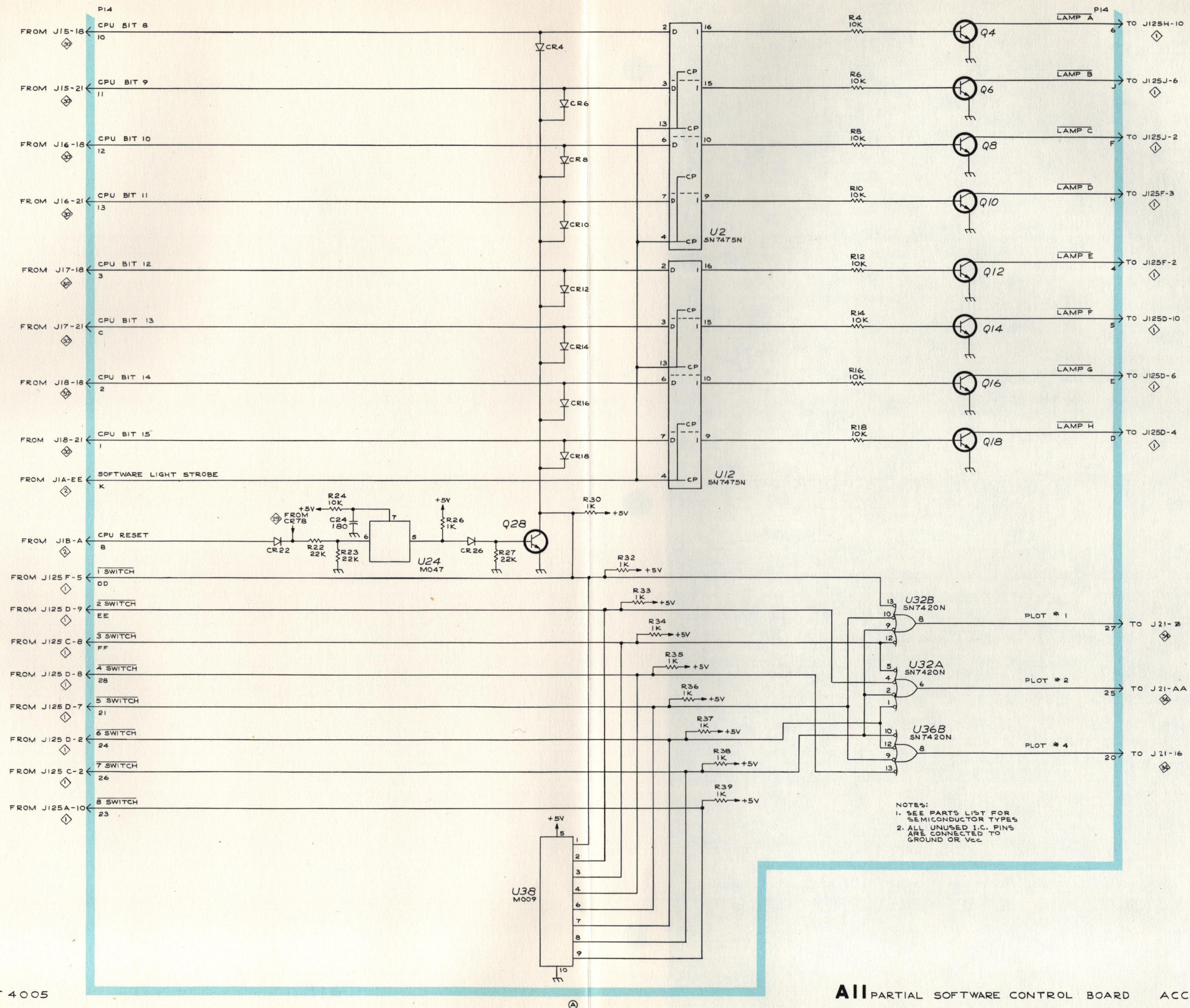


A 10 Power Supply.



NOTE:
SEE PARTS LIST FOR
SEMICONDUCTOR TYPES



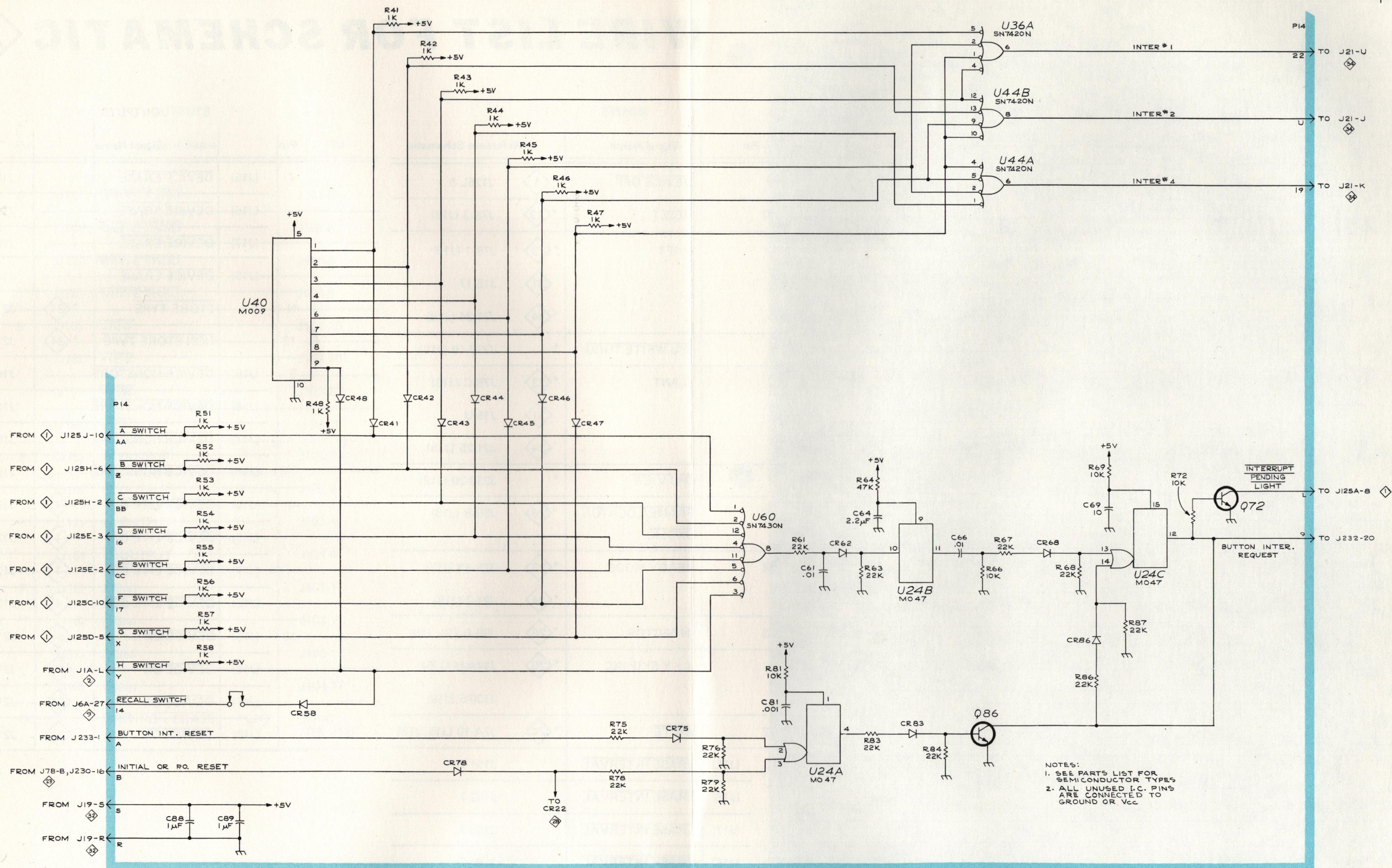


T 4005

Acc-4 PARTIAL SOFTWARE CONTROL BOARD

ACC4

1170



T4005

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Acc-4 PARTIAL SOFTWARE CONTROL BOARD ACC 4

WIRE LIST FOR SCHEMATIC 30

INPUTS		
Pin	Signal Name	Reference Schematic
20	ERASE	* 2 J1A-N (J15)
26	P. O. RST	* 24 J7B-5 (J18)
18 (J15)	CPU Bit 8	28 J14-10
		35 J22-49A
	(J16) CPU Bit 10	28 J14-12
		35 J22-49B
(J17)	CPU Bit 12	28 J14-3
		J232-15
(J18)	CPU Bit 14	28 J14-2
		J232-14
21 (J15)	CPU Bit 9	28 J14-11
		35 J22-50A
	(J16) CPU Bit 11	28 J14-13
		35 J22-50B
(J17)	CPU Bit 13	28 J14-C
		J232-18
(J18)	CPU Bit 15	28 J14-1
		J233-22
19 (J15)	DEVICE SW	1 J125L-2
	(J16) DEVICE SW	1 J125J-9
	(J17) DEVICE SW	1 J125H-3
	(J18) DEVICE SW	1 J125E-10
25	SELECT DEVICES	* J232-19 (J18)

INPUTS		
Pin	Signal Name	Reference Schematic
V	DEVICE OFF	* 1 J125L-5
27	RESET	* 23 J7B-3 (J18)
17	SHIFT	* 23 J7B-1 (J15)
		31 J15-17
		* 34 J21-24 (J18)
Y	CPU WRITE THRU	* J233-19 (J18)
U	SLANT	* 23 J7B-C (J15)
		31 J15-U
		* 34 J21-25 (J18)
X	CPU VIEW	* J233-20 (J18)
BB	FRAME/LOCATOR UNBLK	* 26 J8B-B (J18)
24	READY MODE	* 23 J7B-13 (J15)
		* 34 J21-2 (J18)
23	IN SECTOR	* 26 J8B-A (15, J18)
Z	X + Y SKIP INC	* 20 J14A-U (J15)
		J130-5 (J18)
22	WRITE	* 24 J7A-19 (J15, J18)
A (J15)	ERASE INTERVAL	J101-7
	(J16) ERASE INTERVAL	J102-7
	(J17) ERASE INTERVAL	J103-7
	(J18) ERASE INTERVAL	J104-7


OUTPUTS		
Pin	Signal Name	To
7 (J15)	DEVICE ERASE	J101-18
	(J16) DEVICE ERASE	J102-18
	(J17) DEVICE ERASE	J103-18
	(J18) DEVICE ERASE	J104-18
N	STORE TYPE	* 34 J21-T (J18)
12	NON STORE TYPE	* 34 J21-EE (J18)
8 (J15)	DEVICE NONSTORE	J101-6
	(J16) DEVICE NONSTORE	J102-6
	(J17) DEVICE NONSTORE	J103-6
	(J18) DEVICE NONSTORE	J104-6
W (J15)	DEVICE LITE (I)	1 J125K-2
	(J16) DEVICE LITE (II)	1 J125H-9
	(J17) DEVICE LITE (III)	1 J125J-3
	(J18) DEVICE LITE (IV)	1 J125F-10
13 (J15)	DEVICE ON	34 J21-9
	(J16) DEVICE ON	34 J21-15
	(J17) DEVICE ON	34 J21-17
	(J18) DEVICE ON	34 J21-22

*Like pins of connectors J15, 16, 17, and 18 are connected together. The wire from the connector indicated connects to the connector shown in parenthesis.

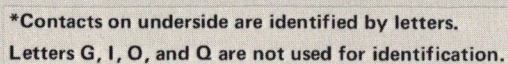
WIRE LIST FOR SCHEMATIC 30

INPUTS		
Signal Name	Reference Schematic	
DEVICE OFF	* 1	J125L-5
RESET	* 23	J7B-3 (J18)
SHIFT	* 23	J7B-1 (J15)
	31	J15-17
	* 34	J21-24 (J18)
CPU WRITE THRU	*	J233-19 (J18)
SLANT	* 23	J7B-C (J15)
	31	J15-U
	* 34	J21-25 (J18)
CPU VIEW	*	J233-20 (J18)
FRAME/LOCATOR	* 26	J8B-B (J18)
UNBLK		
READY MODE	* 23	J7B-13 (J15)
	* 34	J21-2 (J18)
IN SECTOR	* 26	J8B-A (15, J18)
X + Y SKIP INC	* 20	J14A-U (J15)
		J130-5 (J18)
WRITE	* 24	J7A-19 (J15, J18)
ERASE INTERVAL		J101-7
ERASE INTERVAL		J102-7
ERASE INTERVAL		J103-7
ERASE INTERVAL		J104-7

OUTPUTS			
Pin		Signal Name	To
7	(J15)	DEVICE ERASE	J101-18
	(J16)	DEVICE ERASE	J102-18
	(J17)	DEVICE ERASE	J103-18
	(J18)	DEVICE ERASE	J104-18
N		STORE TYPE * 34	J21-T (J18)
12		NON STORE TYPE * 34	J21-EE (J18)
8	(J15)	DEVICE NONSTORE	J101-6
	(J16)	DEVICE NONSTORE	J102-6
	(J17)	DEVICE NONSTORE	J103-6
	(J18)	DEVICE NONSTORE	J104-6
W	(J15)	DEVICE LITE (I) 1	J125K-2
	(J16)	DEVICE LITE (II) 1	J125H-9
	(J17)	DEVICE LITE (III) 1	J125J-3
	(J18)	DEVICE LITE (IV) 1	J125F-10
13	(J15)	DEVICE ON 34	J21-9
	(J16)	DEVICE ON 34	J21-15
	(J17)	DEVICE ON 34	J21-17
	(J18)	DEVICE ON 34	J21-22

OUTPUTS			
Pin		Signal Name	To
D	(J15)	<u>WRITE THRU</u>	J101-8
	(J16)	<u>WRITE THRU</u>	J102-8
	(J17)	<u>WRITE THRU</u>	J103-8
	(J18)	<u>WRITE THRU</u>	J104-8
B	(J15)	<u>VIEW</u>	J101-20
	(J16)	<u>VIEW</u>	J102-20
	(J17)	<u>VIEW</u>	J103-20
	(J18)	<u>VIEW</u>	J104-20
J	(J15)	+Z OUTPUT	J101-4
	(J16)	+Z OUTPUT	J102-4
	(J17)	+Z OUTPUT	J103-4
	(J18)	+Z OUTPUT	J104-4
F	(J15)	Z Gnd	J101-17
	(J16)	Z Gnd	J102-17
	(J17)	Z Gnd	J103-17
	(J18)	Z Gnd	J104-17
CC		<u>WRITING + ERASE</u> * 	J7A-C (J15, J18)


Like pins of connectors J15, 16, 17, and 18 are connected together. The wire from the connector indicated connects to the connector shown in parenthesis.



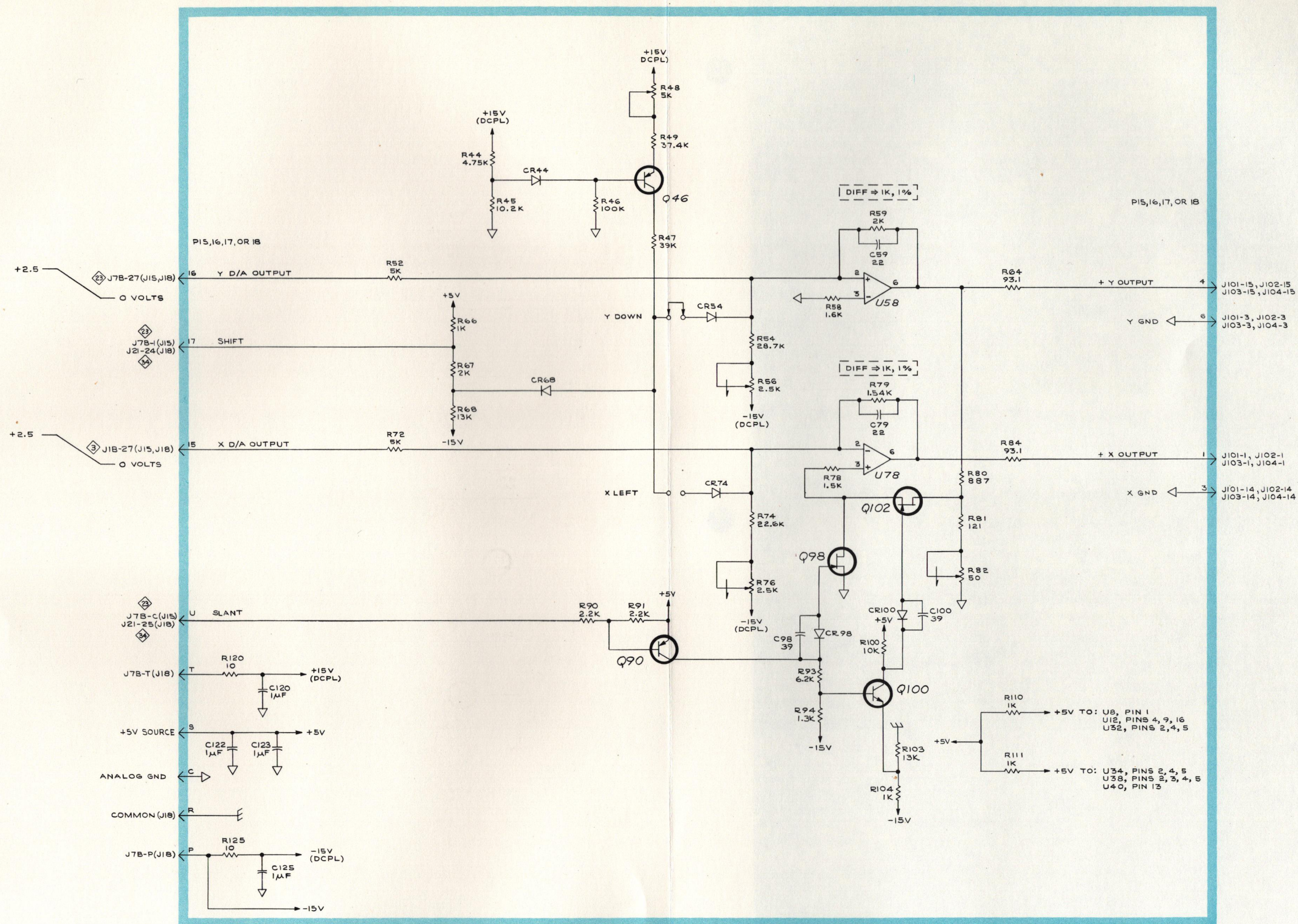
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A12 DISPLAY DEVICE-611
ACC 5,6,7,8

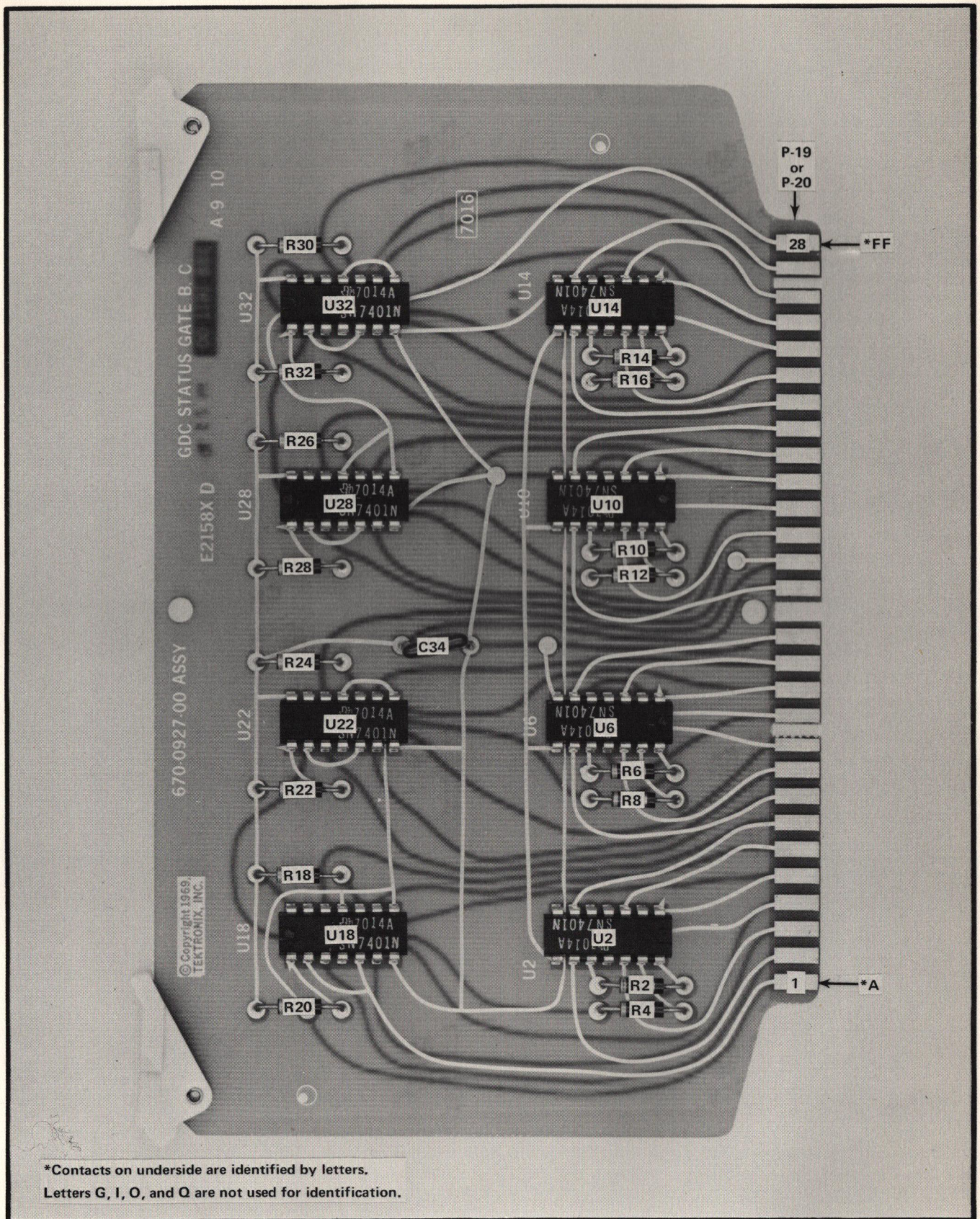
For component layout see photo of Assembly A-12 on schematic  30 .

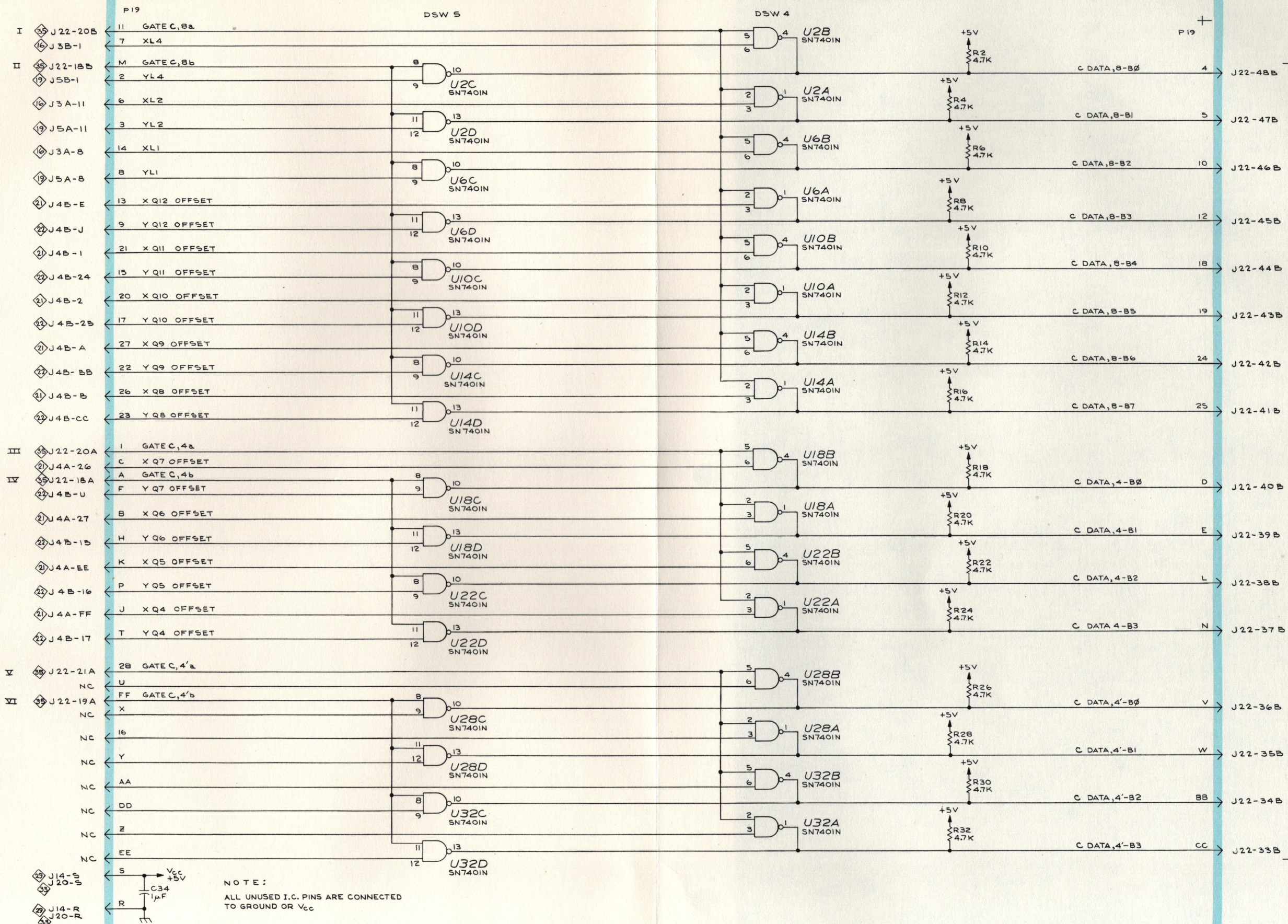
*Like pins of connectors J15, 16, 17, and 18 are connected together. The wire from the connector indicated connects to the connector shown in parenthesis.



NOTES:

1. ALL UNUSED I.C. PINS ARE CONNECTED TO GROUND OR V_{CC}
2. SEE PARTS LIST FOR SEMICONDUCTOR TYPES





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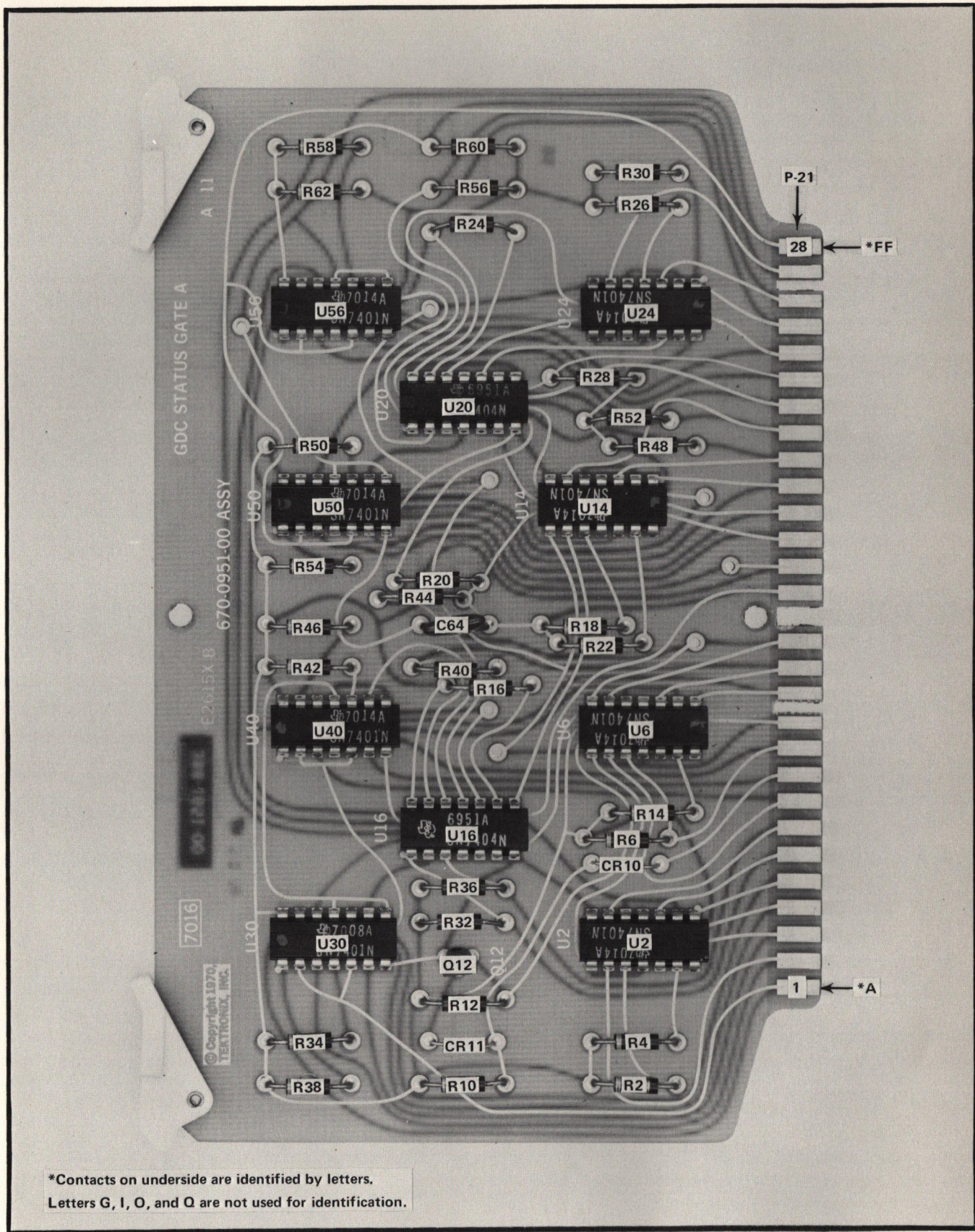
Ⓐ

A13 GDC STATUS WORD ACC-9

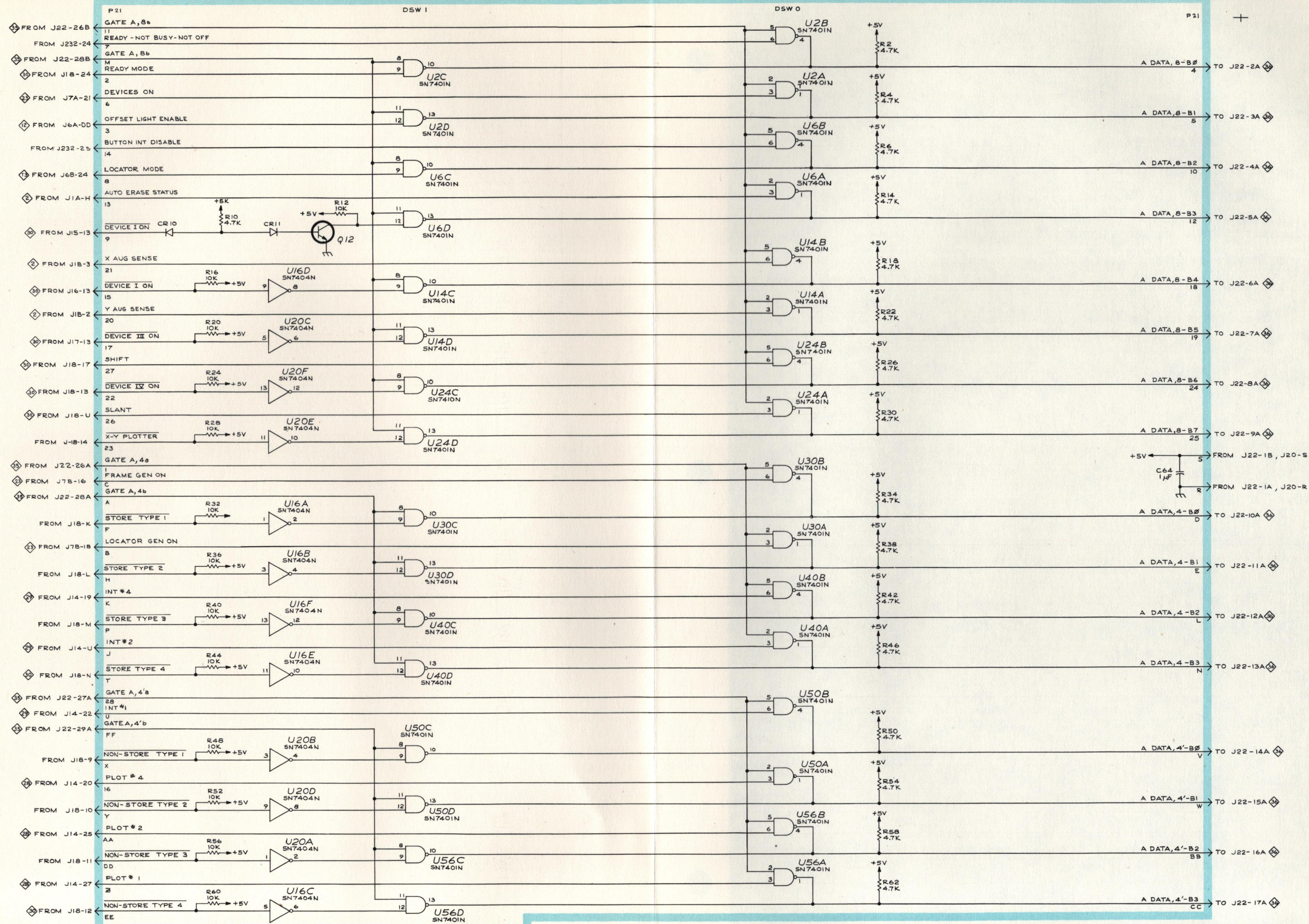
GRS
1170

Acc-9 GDC STATUS
WORD

32

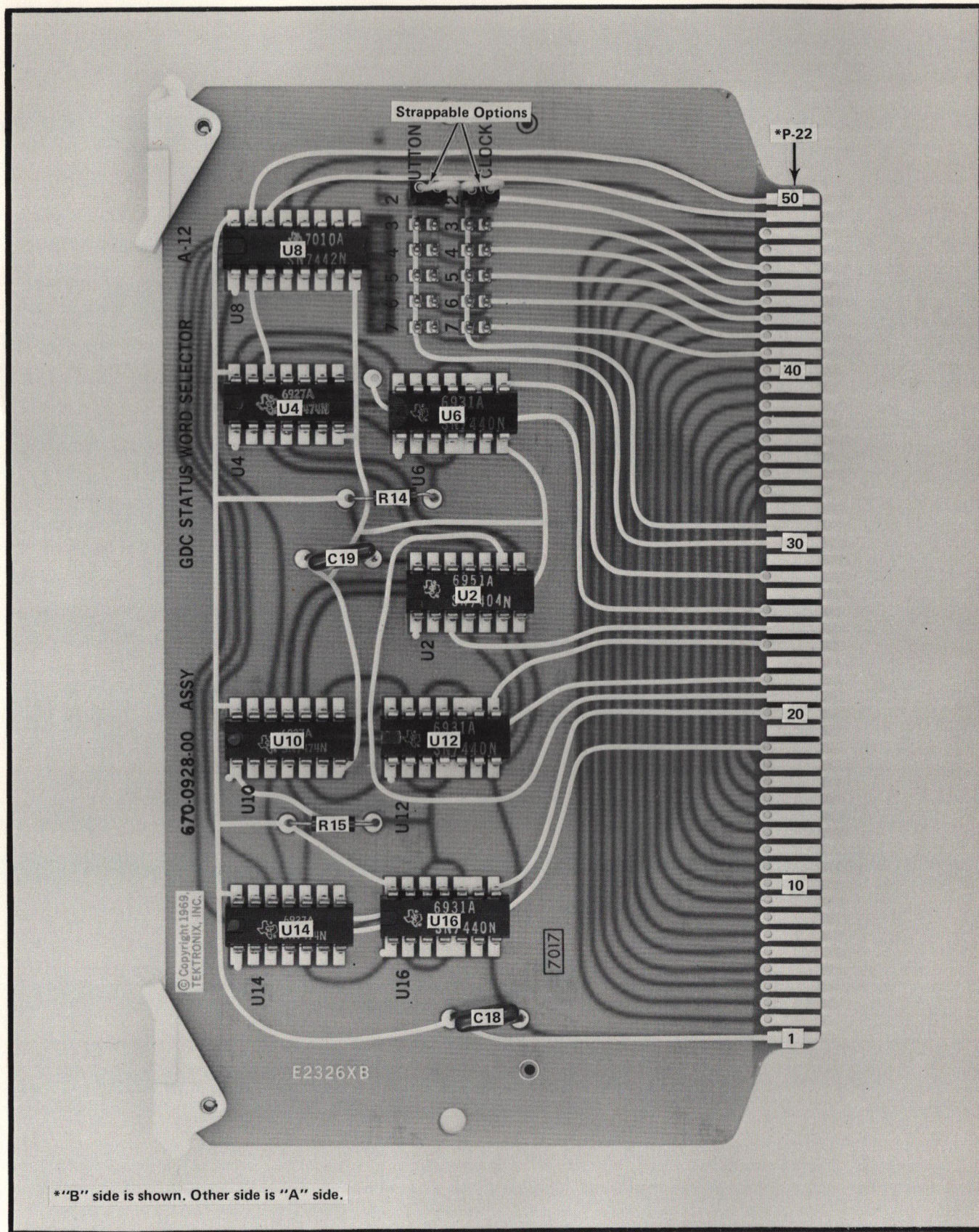


A 15 GDC Status Gate A (Acc-11).

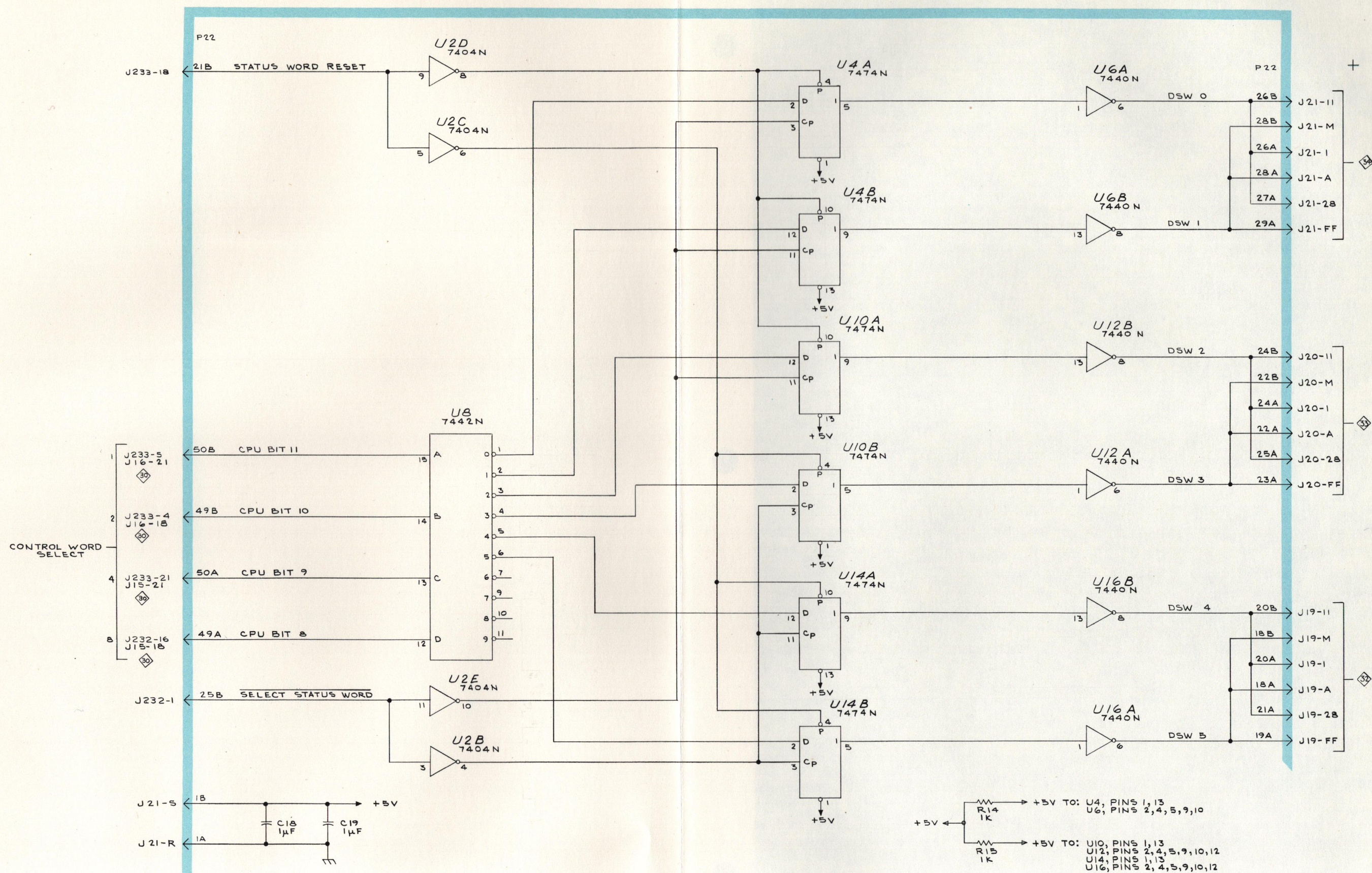


NOTES:
1. SEE PARTS LIST FOR SEMICONDUCTOR TYPES.
2. ALL UNUSED I.C. PINS ARE CONNECTED TO V_{cc} OR GND

A15 GDC STATUS GATE A ACC 11 1170



A 16 GDC Status Word Selector (Acc-12).



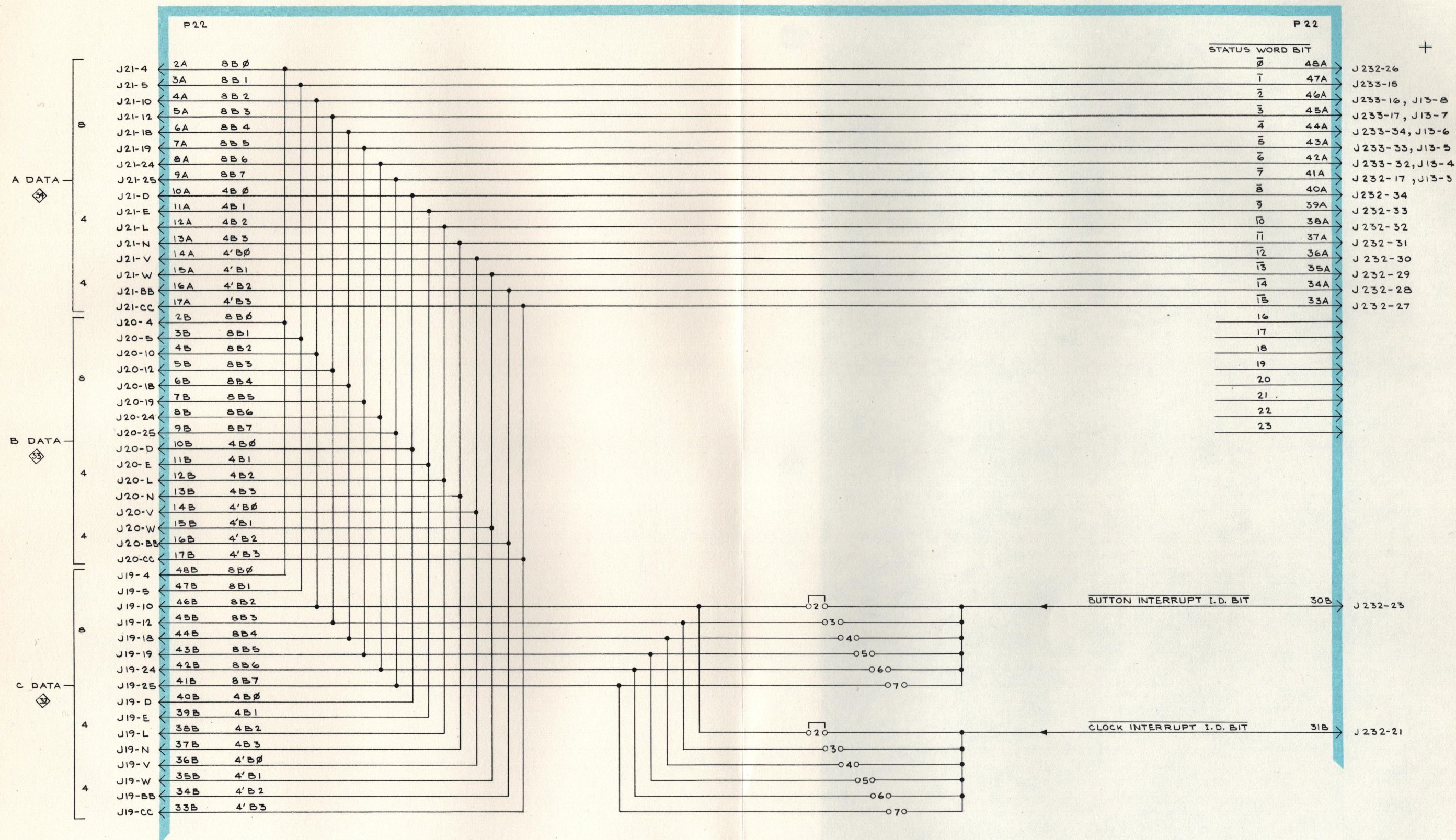
T4005

Ⓐ

A16 GDC STATUS GATE SELECTOR

35

hq
1170



T4005

Ⓐ

A16 GDC STATUS WORD SELECTOR 36 hq
ACC-12

Acc-12 GDC STATUS
WORD SELECTOR

36

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear either on the back of the diagrams or on pullout pages immediately following the diagrams of the instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicated item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
Detail Part of Assembly and/or Component
mounting hardware for Detail Part
Parts of Detail Part
mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

INDEX OF MECHANICAL PARTS LIST & ILLUSTRATIONS

Title	Page Nos. of Parts List
Figure 1 Control Panel	6-1 thru 6-3
Figure 2 Chassis	6-4 thru 6-12
Figure 3 Cabinet	6-13

SECTION 6

MECHANICAL PARTS LIST

FIGURE 1 CONTROL PANEL

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q						Description
				t	y	1	2	3	4	
1-	640-0493-00			1						CONTROL PANEL ASSEMBLY
	- - - - -			-						control panel assembly includes:
-1	380-0197-00			1						HOUSING, control panel
-2	200-1102-00			1						COVER, subpanel
	- - - - -			-						mounting hardware: <i>(not included w/cover)</i>
-3	212-0004-00			4						SCREW, 8-32 x 0.312 inch, PHS
-4	211-0507-00			4						SCREW, 6-32 x 0.312 inch, PHS
-5	670-0934-00			1						CIRCUIT BOARD ASSEMBLY—CONTROL PANEL
	- - - - -			-						circuit board assembly includes:
	388-1618-00			1						CIRCUIT BOARD
-6	131-0589-00			100						TERMINAL, pin, 0.50 inch long
-7	136-0370-00			49						LAMP HOLDER, plastic
-8	214-0628-00			49						SPRING, flat, pushbutton
-9	210-0702-00			245						EYELET
	- - - - -			-						mounting hardware: <i>(not included w/circuit board assembly)</i>
-10	211-0504-00			2						SCREW, 6-32 x 0.25 inch, PHS
-11	210-1011-00			1						WASHER, plastic, 0.13 ID x 0.375 inch OD
-12	366-1200-01			2						PUSHBUTTON—8 k
	366-1200-02			2						PUSHBUTTON—4 k
	366-1200-03			2						PUSHBUTTON—2 k
	366-1200-04			2						PUSHBUTTON—1 k
	366-1200-05			2						PUSHBUTTON—512
	366-1200-06			2						PUSHBUTTON—256
-13	366-1200-07			1						PUSHBUTTON—VERT
	366-1200-08			1						PUSHBUTTON—HORIZ
-14	366-1200-09			1						PUSHBUTTON—READY
	366-1200-10			1						PUSHBUTTON—FRAME
	366-1200-11			1						PUSHBUTTON—LOCATE
	366-1200-22			1						PUSHBUTTON—FAST
	366-1200-39			1						PUSHBUTTON—HOME
-15	366-1200-12			1						PUSHBUTTON—OFF
	366-1200-13			1						PUSHBUTTON—I
	366-1200-14			1						PUSHBUTTON—II
	366-1200-15			1						PUSHBUTTON—III
	366-1200-16			1						PUSHBUTTON—IV

FIGURE 1 CONTROL PANEL (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q					Description
				t	1	2	3	4	
-16	366-1200-17			1					PUSHBUTTON—INITIAL
-17	366-1200-18			1					PUSHBUTTON—RETAIN
	366-1200-19			1					PUSHBUTTON—RECALL
-18	366-1200-20			1					PUSHBUTTON—AUTO
	366-1200-21			1					PUSHBUTTON—MAN
-19	366-1200-23			1					PUSHBUTTON—1
	366-1200-24			1					PUSHBUTTON—2
	366-1200-25			1					PUSHBUTTON—3
	366-1200-26			1					PUSHBUTTON—4
	366-1200-27			1					PUSHBUTTON—5
	366-1200-28			1					PUSHBUTTON—6
	366-1200-29			1					PUSHBUTTON—7
	366-1200-30			1					PUSHBUTTON—8
-20	366-1200-31			1					PUSHBUTTON—A
	366-1200-32			1					PUSHBUTTON—B
	366-1200-33			1					PUSHBUTTON—C
	366-1200-34			1					PUSHBUTTON—D
	366-1200-35			1					PUSHBUTTON—E
	366-1200-36			1					PUSHBUTTON—F
	366-1200-37			1					PUSHBUTTON—G
	366-1200-38			1					PUSHBUTTON—H
-21	337-1285-00			1					SHIELD, light
-22	378-0781-00			1					LENS, status, rear
-23	334-1538-00			1					FILM, identification, status
-24	378-0663-00			1					LENS, status, front
-25	366-1199-00			4					PUSHBUTTON, position
-26	386-1736-00			1					SUBPANEL, front
-27	333-1318-02			1					PANEL, front
-28	334-1555-00			1					PLATE, identification
	175-1172-00			1					CABLE, special purpose electrical, power switch
	- - - - -			-					cable includes:
-29	260-1179-00			1					SWITCH, rocker—POWER
-30	131-0946-00			1					CONNECTOR SHELL
-31	131-0945-00			4					CONTACT, electrical, male
	- - - - -			-					mounting hardware: (not included w/cable)
-32	213-0054-00			2					SCREW, thread cutting, 6-32 x 0.312 inch, PHS
	- - - - -			-					mounting hardware: (not included w/control panel assembly)
	212-0045-00			4					SCREW, 8-32 x 0.50 inch, THS

FIGURE 1 CONTROL PANEL (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Q † Y	1	2	3	4	5	Description
		Eff	Disc							
	175-1200-00			1						CABLE, special purpose, electrical, interconnecting
	-			-						cable includes:
-33	343-0282-00			10						RETAINER, connector
-34	380-0204-00			2						HOUSING, connector
-35	352-0168-08			2						HOLDER, terminal connector, 10 wire (gray)
	352-0168-00			2						HOLDER, terminal connector, 10 wire (black)
	352-0168-01			2						HOLDER, terminal connector, 10 wire (brown)
	352-0168-02			2						HOLDER, terminal connector, 10 wire (red)
	352-0168-03			2						HOLDER, terminal connector, 10 wire (orange)
	352-0168-04			2						HOLDER, terminal connector, 10 wire (yellow)
	352-0168-05			2						HOLDER, terminal connector, 10 wire (green)
	352-0168-06			2						HOLDER, terminal connector, 10 wire (blue)
	352-0168-07			2						HOLDER, terminal connector, 10 wire (violet)
	352-0168-09			2						HOLDER, terminal connector, 10 wire (white)
-36	131-0707-00			200						CONNECTOR, terminal
-37	175-0833-00			ft						WIRE, 10 wire ribbon, cut in 10, 15 inch lengths
-38	211-0016-00			4						SCREW, 4-40 x 0.625 inch, RHS
-39	105-0192-00			4						EJECTOR, connector
-40	220-0590-00			4						NUT, rectangular, 4-40 x 0.39 inch

100-100000-100000

100-100000-100000

100-100000-100000

100-100000-100000

100-100000-100000

100-100000-100000

100-100000-100000

100-100000-100000

100-100000-100000

100-100000-100000

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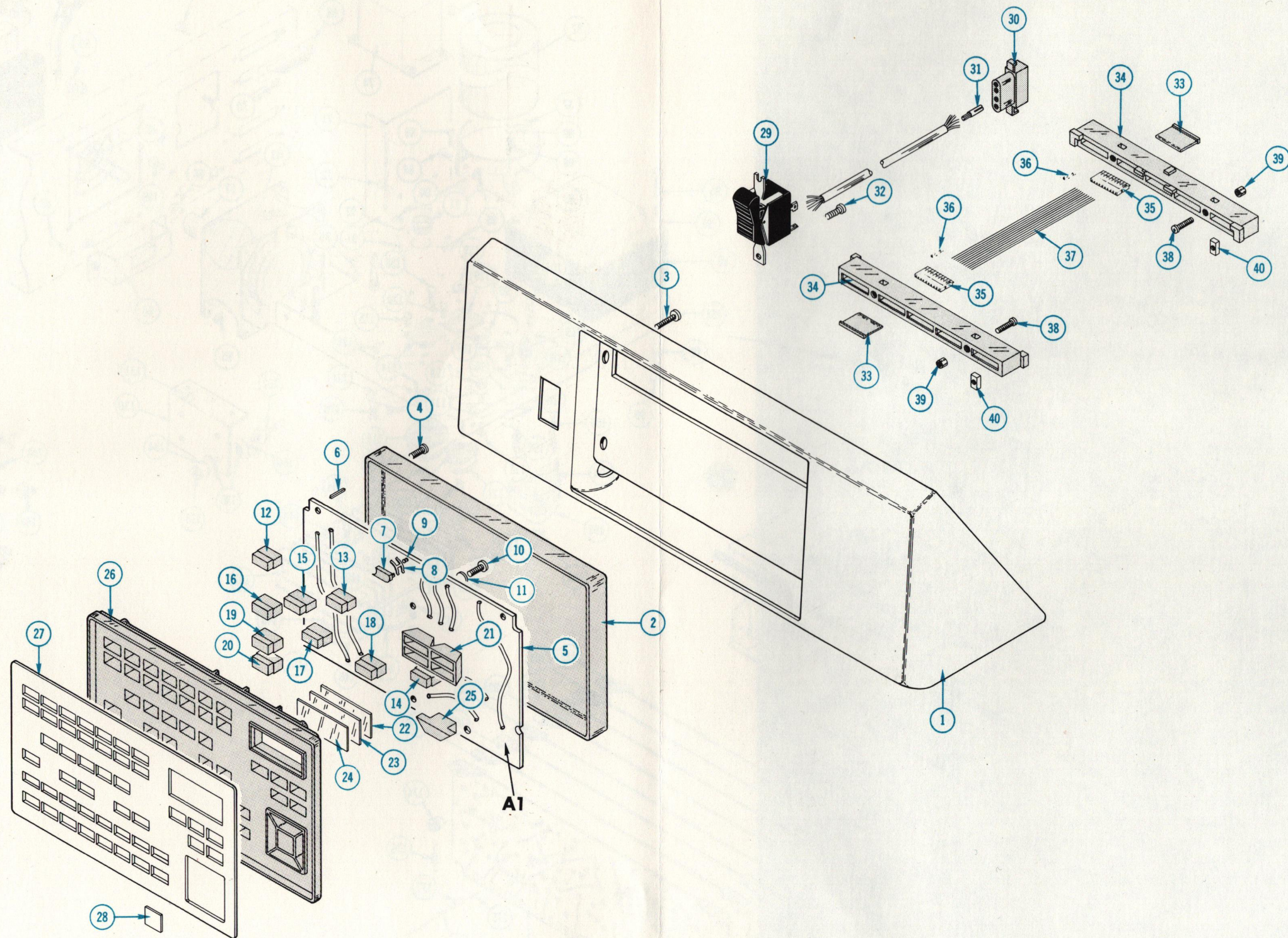


FIG. 1 CONTROL PANEL

T4005/4201 GRAPHIC DISPLAY CONTROLLER

FIG. 2 CHASSIS

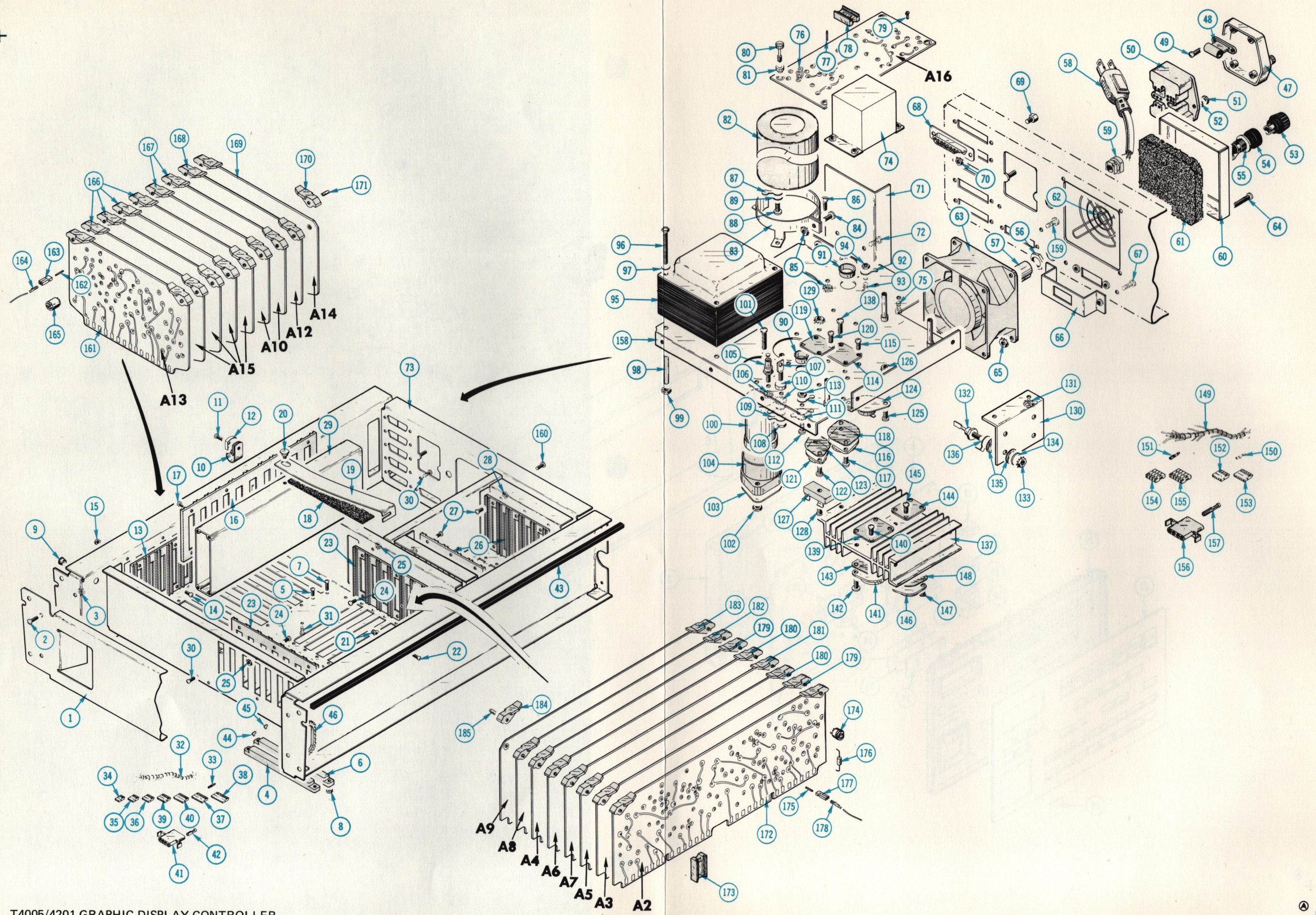


FIGURE 2 CHASSIS

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q † y 1 2 3 4 5					Description
2-1	426-0624-00			1					FRAME SECTION, cabinet, lower front
-2	211-0507-00			-					mounting hardware: <i>(not included w/frame section)</i>
-3	210-0457-00			4					SCREW, 6-32 x 0.312 inch, PHS
				4					NUT, keps, 6-32 x 0.312 inch
-4	131-0549-00			27					CONNECTOR, receptacle, female, 56 pin
-5	211-0008-00			-					mounting hardware for each: <i>(not included w/connector)</i>
				2					SCREW, 4-40 x 0.25 inch, PHS
-6	131-0931-00			1					CONNECTOR, receptacle
-7	211-0014-00			-					mounting hardware: <i>(not included w/connector)</i>
-8	210-0586-00			2					SCREW, 4-40 x 0.50 inch, PHS
				2					NUT, keps, 4-40 x 0.25 inch
-9	348-0056-00			2					GROMMET, plastic, 0.375 inch diameter
-10	343-0006-00			1					CLAMP, cable, plastic, 0.50 inch diameter
-11	211-0510-00			-					mounting hardware: <i>(not included w/clamp)</i>
-12	210-0863-00			1					SCREW, 6-32 x 0.375 inch, PHS
				1					WASHER, D shape, 0.191 ID x 0.515 inch
-13	351-0238-00			1					GUIDE, circuit card, auxiliary
-14	211-0507-00			-					mounting hardware: <i>(not included w/guide)</i>
-15	210-0457-00			8					SCREW, 6-32 x 0.312 inch, PHS
				8					NUT, keps, 6-32 x 0.312 inch
-16	351-0238-00			1					GUIDE, circuit card, auxiliary
-17	213-0041-00			-					mounting hardware: <i>(not included w/guide)</i>
				8					SCREW, thread cutting, 6-32 x 0.375 inch, THS
-18	253-0056-00			ft					TAPE, plastic foam, 6.60 inches long
-19	386-1735-00			1					SUPPORT, circuit card
-20	212-0593-00			-					mounting hardware: <i>(not included w/support)</i>
				1					SCREW, shouldered, 10-32 x 0.437 inch
-21	214-0044-00			1					LATCH, fastening
-22	211-0008-00			-					mounting hardware: <i>(not included w/latch)</i>
	361-0352-00			1					SCREW, 4-40 x 0.25 inch, PHS
				1					SPACER, ring, 0.193 ID x 0.355 inch OD <i>(not shown)</i>

FIGURE 2 CHASSIS (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q t y						Description
					1	2	3	4	5	
-23	351-0239-00	- - - - -		2						GUIDE, circuit card, main
-24	211-0507-00	- - - - -		-						mounting hardware for each: <i>(not included w/guide)</i>
-25	210-0457-00	- - - - -		6						SCREW, 6-32 x 0.312 inch, PHS
		- - - - -		6						NUT, keps, 6-32 x 0.312 inch
-26	351-0250-00	- - - - -		2						GUIDE, circuit card, interface
-27	211-0507-00	- - - - -		-						mounting hardware for each: <i>(not included w/guide)</i>
-28	210-0457-00	- - - - -		6						SCREW, 6-32 x 0.312 inch, PHS
		- - - - -		6						NUT, keps, 6-32 x 0.312 inch
-29	426-0625-00	- - - - -		1						FRAME SECTION, center, air duct
-30	211-0008-00	- - - - -		-						mounting hardware: <i>(not included w/frame section)</i>
-31	211-0504-00	- - - - -		8						SCREW, 4-40 x 0.25 inch, PHS
		- - - - -		4						SCREW, 6-32 x 0.25 inch, PHS
-32	179-1571-00	- - - - -		1						WIRING HARNESS
	179-1553-00	- - - - -		1						WIRING HARNESS, interconnecting
	179-1552-00	- - - - -		1						WIRING HARNESS, IF control
	- - - - -	- - - - -		-						wiring harness includes:
-33	131-0707-00	- - - - -		38						CONNECTOR, terminal
-34	352-0161-00	- - - - -		3						HOLDER, terminal connector, 3 wire <i>(black)</i>
-35	352-0162-00	- - - - -		1						HOLDER, terminal connector, 4 wire <i>(black)</i>
-36	352-0163-00	- - - - -		2						HOLDER, terminal connector, 5 wire <i>(black)</i>
-37	352-0166-00	- - - - -		1						HOLDER, terminal connector, 8 wire <i>(black)</i>
-38	352-0167-00	- - - - -		1						HOLDER, terminal connector, 9 wire <i>(black)</i>
	179-1551-00	- - - - -		1						WIRING HARNESS, control
	- - - - -	- - - - -		-						wiring harness includes:
	131-0707-00	- - - - -		51						CONNECTOR, terminal
	352-0162-00	- - - - -		1						HOLDER, terminal connector, 4 wire <i>(black)</i>
	352-0163-00	- - - - -		1						HOLDER, terminal connector, 5 wire <i>(black)</i>
-39	352-0164-00	- - - - -		1						HOLDER, terminal connector, 6 wire <i>(black)</i>
-40	352-0165-00	- - - - -		3						HOLDER, terminal connector, 7 wire <i>(black)</i>
	352-0166-00	- - - - -		1						HOLDER, terminal connector, 8 wire <i>(black)</i>
	352-0167-00	- - - - -		1						HOLDER, terminal connector, 9 wire <i>(black)</i>
	175-1171-00	- - - - -		1						CABLE, special purpose, electrical
	- - - - -	- - - - -		-						cable includes:
-41	131-0947-00	- - - - -		1						CONNECTOR SHELL
-42	131-0948-00	- - - - -		4						CONTACT, electrical, female
-43	255-0249-00	- - - - -		ft						PLASTIC CHANNEL, 7.5 feet

FIGURE 2 CHASSIS (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q					Description
				t	y	1	2	3	
-44	214-0702-00			40					KEY, polarizing, connector, plastic
-45	214-1458-00			2					KEY, connector
-46	255-0334-00			ft					PLASTIC CHANNEL
-47	200-0762-00			1					COVER, line voltage selector
-	- - - - -			-					cover includes:
-48	352-0102-00			2					HOLDER, fuse
-	- - - - -			-					mounting hardware for each: <i>(not included w/holder)</i>
-49	213-0088-00			2					SCREW, thread forming, #4 x 0.25 inch, PHS
-50	204-0441-00			1					BODY, line voltage selector
-	- - - - -			-					mounting hardware: <i>(not included w/body)</i>
-51	210-0407-00			2					NUT, hex., 6-32 x 0.25 inch
-52	210-0006-00			2					WASHER, lock, internal, #6
	352-0002-00			1					FUSE HOLDER ASSEMBLY
-	- - - - -			-					fuse holder assembly includes:
-53	200-0582-00			1					CAP, fuse
-54	352-0010-00			1					HOLDER, fuse
-55	210-0873-00			1					WASHER, rubber, 0.50 ID x 0.638 inch OD
-56	- - - - -			1					NUT, fuse holder
-57	200-0237-00			1					COVER, fuse holder
-58	161-0006-00			1					CABLE ASSEMBLY, power
-59	358-0025-00			1					BUSHING, strain relief
-60	378-0780-00			1					SCREEN, fan
-61	378-0647-00			1					FILTER, air, 3.125 inches square
-62	343-0263-00			1					RETAINER, filter
-63	119-0215-00			1					FAN ASSEMBLY
-	- - - - -			-					mounting hardware: <i>(not included w/fan assembly)</i>
-64	211-0516-00			4					SCREW, 6-32 x 0.875 inch, PHS
-65	210-0457-00			4					NUT, keps, 6-32 x 0.312 inch
-66	407-0786-00			1					BRACKET, component mounting
-	- - - - -			-					mounting hardware: <i>(not included w/bracket)</i>
-67	211-0565-00			2					SCREW, 6-32 x 0.25 inch, THS
-68	131-0569-00			4					CONNECTOR, receptacle
-	- - - - -			-					mounting hardware for each: <i>(not included w/connector)</i>
-69	129-0260-00			2					POST, stud, 4-40, w/countersink
-70	210-0586-00			2					NUT, keps, 4-40 x 0.25 inch
-71	337-1360-00			1					SHIELD, electrical, power supply
-	- - - - -			-					mounting hardware: <i>(not included w/shield)</i>
-72	211-0504-00			2					SCREW, 6-32 x 0.25 inch, PHS
-73	441-0963-00			1					CHASSIS-FRAME ASSEMBLY
	200-0865-00			2					COVER, connector mounting hole
-	- - - - -			-					mounting hardware for each: <i>(not included w/cover)</i>
	211-0008-00			2					SCREW, 4-40 x 0.25 inch, PHS

FIGURE 2 CHASSIS (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q † y						Description
					1	2	3	4	5	
-74	- - - - -			1						LINE FILTER
	- - - - -			-						mounting hardware: <i>(not included w/line filter)</i>
-75	211-0008-00			4						SCREW, 4-40 x 0.25 inch, PHS
-76	670-0933-00			1						CIRCUIT BOARD ASSEMBLY—POWER SUPPLY A16
	- - - - -			-						circuit board assembly includes:
	388-1617-00			1						CIRCUIT BOARD
-77	131-0589-00			9						TERMINAL, pin, 0.50 inch long
	131-0608-00			17						TERMINAL, pin, 0.365 inch long
-78	136-0269-00			3						SOCKET, integrated circuit, 14 pin
-79	214-0579-00			3						PIN, test point
-80	211-0155-00			4						SCREW, relieved shank, 4-40 x 0.375 inch
-81	361-0301-00			4						SPACER, sleeve
-82	- - - - -			1						CAPACITOR
	- - - - -			-						mounting hardware: <i>(not included w/capacitor)</i>
-83	343-0064-00			1						CLAMP, capacitor mounting
-84	212-0008-00			1						SCREW, 8-32 x 0.50 inch, PHS
-85	210-0458-00			4						NUT, keps, 8-32 x 0.344 inch
-86	212-0004-00			3						SCREW, 8-32 x 0.312 inch, PHS
-87	210-0224-00			2						LUG, solder, SE #10
	- - - - -			-						mounting hardware for each: <i>(not included w/lug)</i>
-88	212-0518-00			1						SCREW, 10-32 x 0.312 inch, PHS
-89	210-0010-00			1						WASHER, lock, internal #10
-90	348-0063-00			2						GROMMET, plastic, 0.50 inch diameter
-91	348-0064-00			1						GROMMET, plastic, 0.625 inch diameter
-92	210-0202-00			1						LUG, solder, SE #6
	- - - - -			-						mounting hardware: <i>(not included w/lug)</i>
-93	211-0507-00			1						SCREW, 6-32 x 0.312 inch, PHS
-94	210-0457-00			1						NUT, keps, 6-32 x 0.312 inch
-95	- - - - -			1						TRANSFORMER
	- - - - -			-						transformer includes:
-96	212-0522-00			4						SCREW, 10.32 x 2.50 inches HHS
-97	210-0812-00			4						WASHER, fiber, shouldered, #10
-98	166-0434-00			4						TUBE, bolt insulating, 2.25 inches long
	- - - - -			-						mounting hardware: <i>(not included w/transformer)</i>
-99	220-0410-00			4						NUT, keps, 10-32 x 0.375 inch
-100	- - - - -			2						CAPACITOR
	- - - - -			-						mounting hardware for each: <i>(not included w/capacitor)</i>
-101	211-0516-00			2						SCREW, 6-32 x 0.875 inch, PHS
-102	210-0457-00			2						NUT, keps, 6-32 x 0.312 inch
-103	386-0254-00			1						PLATE, fiber, large
-104	432-0048-00			1						BASE, capacitor mounting, large

FIGURE 2 CHASSIS (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q t y 1 2 3 4 5					Description
-105	129-0006-00			1					POST, connecting, insulated
	- - - - -			-					mounting hardware: (not included w/post)
-106	210-0457-00			1					NUT, keps, 6-32 x 0.312 inch
-107	214-0012-00			1					BOLT, spade, 6-32 x 0.375 inch
	- - - - -			-					mounting hardware: (not included w/bolt)
-108	210-0457-00			1					NUT, keps, 6-32 x 0.312 inch
-109	210-0202-00			2					LUG, solder, SE #6
-110	210-1111-00			2					WASHER, shouldered, plastic
-111	210-0202-00			3					LUG, solder, SE #6
	- - - - -			-					mounting hardware: (not included w/lugs)
-112	211-0507-00			1					SCREW, 6-32 x 0.312 inch, PHS
-113	210-0457-00			1					NUT, keps, 6-32 x 0.312 inch
-114	136-0280-00			1					SOCKET, transistor, large
	- - - - -			-					mounting hardware: (not included w/socket)
-115	213-0088-00			2					SCREW, thread forming, 4-40 x 0.25 inch, PHS
-116	- - - - -			1					TRANSISTOR
	- - - - -			-					mounting hardware: (not included w/transistor)
-117	213-0041-00			2					SCREW, thread cutting, 6-32 x 0.375 inch, THS
-118	386-0978-00			1					PLATE, mica, 1.17 x 1.17 inches
-119	136-0270-00			2					SOCKET, transistor, small
	- - - - -			-					mounting hardware for each: (not included w/socket)
-120	213-0088-00			2					SCREW, thread cutting, 4-40 x 0.25 inch, PHS
-121	- - - - -			2					TRANSISTOR
	- - - - -			-					mounting hardware for each: (not included w/transistor)
-122	213-0041-00			2					SCREW, thread cutting, 6-32 x 0.375 inch, THS
-123	386-0143-00			1					PLATE, mica, 0.80 x 1.35 inches
-124	- - - - -			1					THERMO CUTOUT
	- - - - -			-					mounting hardware: (not included w/thermo cutout)
-125	211-0097-00			2					SCREW, 4-40 x 0.312 inch, PHS
-126	210-0586-00			2					NUT, keps, 4-40 x 0.312 inch
-127	352-0031-00			1					HOLDER, fuse, single
	- - - - -			-					mounting hardware: (not included w/holder)
-128	211-0510-00			1					SCREW, 6-32 x 0.375 inch, PHS
-129	210-0457-00			1					NUT, keps, 6-32 x 0.312 inch

FIGURE 2 CHASSIS (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q					Description
				t	1	2	3	4	
-130	407-0752-00			1					BRACKET, component mounting
	- - - - -			-					mounting hardware: <i>(not included w/bracket)</i>
-131	210-0457-00			2					NUT, keps, 6-32 x 0.312 inch
-132	- - - - -			4					DIODE
	- - - - -			-					mounting hardware for each: <i>(not included w/diode)</i>
-133	220-0410-00			1					NUT, keps, 10-32 x 0.375 inch
-134	210-0805-00			4					WASHER, flat, #10 x 0.438 inch
-135	210-0909-00			4					WASHER, mica, insulating
-136	210-0224-00			4					LUG, solder, SE #10
-137	214-1341-00			1					HEAT SINK
	- - - - -			-					mounting hardware: <i>(not included w/heat sink)</i>
-138	212-0004-00			1					SCREW, 8-32 x 0.312 inch, PHS
	212-0008-00			2					SCREW, 8-32 x 0.50 inch, PHS <i>(not shown)</i>
-139	136-0280-00			1					SOCKET, transistor, large
	- - - - -			-					mounting hardware: <i>(not included w/socket)</i>
-140	213-0088-00			2					SCREW, thread cutting, 6-32 x 0.375 inch, THS
-141	- - - - -			1					TRANSISTOR
	- - - - -			-					mounting hardware: <i>(not included w/transistor)</i>
-142	213-0041-00			2					SCREW, thread cutting, 6-32 x 0.375 inch, THS
-143	386-0978-00			1					PLATE, mica, 1.17 x 1.17 inches
-144	136-0270-00			1					SOCKET, transistor, small
	- - - - -			-					mounting hardware: <i>(not included w/socket)</i>
-145	213-0088-00			2					SCREW, thread cutting, 4-40 x 0.25 inch, PHS
-146	- - - - -			1					TRANSISTOR
	- - - - -			-					mounting hardware: <i>(not included w/transistor)</i>
-147	213-0041-00			2					SCREW, thread cutting, 6-32 x 0.375 inch, THS
-148	386-0143-00			1					PLATE, mica, 0.80 x 1.35 inches
-149	179-1554-00			1					WIRING HARNESS, power
	- - - - -			-					wiring harness includes:
-150	131-0707-00			17					CONNECTOR, terminal
-151	131-0621-00			9					CONNECTOR, terminal
-152	352-0163-00			1					HOLDER, terminal connector, 5 wire <i>(black)</i>
-153	352-0164-00			2					HOLDER, terminal connector, 6 wire <i>(black)</i>
-154	352-0200-00			1					HOLDER, terminal connector, 4 wire <i>(black)</i>
-155	352-0201-00			1					HOLDER, terminal connector, 5 wire <i>(black)</i>

FIGURE 2 CHASSIS (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q t y	1	2	3	4	5	Description
	179-1555-00			1						WIRING HARNESS, line voltage
	- - - - -			-						wiring harness includes:
-156	131-0947-00			1						CONNECTOR SHELL
-157	131-0948-00			4						CONTACT, electrical, female
-158	441-0925-00			1						CHASSIS, power supply
	- - - - -			-						mounting hardware: <i>(not included w/chassis)</i>
-159	211-0507-00			6						SCREW, 6-32 x 0.312 inch, PHS
-160	211-0565-00			2						SCREW, 6-32 x 0.25 inch, THS
-161	670-0922-00			1						CIRCUIT CARD ASSEMBLY—PARTIAL SOFTWARE CONTROL A13
	- - - - -			-						circuit card includes:
	388-1606-00			1						CIRCUIT CARD
	105-0171-00			2						EJECTOR, circuit card
	- - - - -			-						mounting hardware for each: <i>(not included w/ejector)</i>
	214-1337-00			1						PIN, spring, 0.10 OD x 0.25 inch long
-162	131-0608-00			3						TERMINAL, pin, 0.365 inch long
	131-0993-00			1						LINK, terminal connector
	- - - - -			-						link includes:
-163	352-0169-00			1						HOLDER, terminal connector, 2 wire <i>(black)</i>
-164	131-0707-00			2						CONNECTOR, terminal
-165	136-0241-00			2						SOCKET, integrated circuit, 10 pin
-166	670-0926-00			4						CIRCUIT CARD ASSEMBLY—DISPLAY CONTROLLER A15
	- - - - -			-						each circuit card assembly includes:
	388-1610-00			1						CIRCUIT CARD
	105-0171-00			2						EJECTOR, circuit card
	- - - - -			-						mounting hardware for each: <i>(not included w/ejector)</i>
	214-1337-00			1						PIN, spring, 0.10 OD x 0.25 inch long
	131-0608-00			4						TERMINAL, pin, 0.365 inch long
	131-0993-00			1						LINK, terminal connector
	- - - - -			-						link includes:
	352-0169-00			1						HOLDER, terminal connector, 2 wire <i>(black)</i>
	131-0707-00			2						CONNECTOR, terminal
	136-0237-00			2						SOCKET, integrated circuit, 8 pin
-167	670-0927-00			2						CIRCUIT CARD ASSEMBLY—STATUS WORD A10
	- - - - -			-						each circuit card assembly includes:
	388-1611-00			1						CIRCUIT CARD
	105-0171-00			2						EJECTOR, circuit card
	- - - - -			-						mounting hardware for each: <i>(not included w/ejector)</i>
	214-1337-00			1						PIN, spring, 0.10 OD x 0.25 inch long

FIGURE 2 CHASSIS (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q † y						Description
					1	2	3	4	5	
-168	670-0951-00			1						CIRCUIT CARD ASSEMBLY—STATUS GATE (A) A12
	- - - - -			-						circuit card assembly includes:
	388-1651-00			1						CIRCUIT CARD
	105-0171-00			2						EJECTOR, circuit card
	- - - - -			-						mounting hardware for each: <i>(not included w/ejector)</i>
	214-1337-00			1						PIN, spring, 0.10 OD x 0.25 inch long
-169	670-0928-00			1						CIRCUIT CARD ASSEMBLY—STATUS GATE SELECTOR A14
	- - - - -			-						circuit card assembly includes:
	388-1612-00			1						CIRCUIT CARD
-170	105-0171-00			2						EJECTOR, circuit card
	- - - - -			-						mounting hardware for each: <i>(not included w/ejector)</i>
-171	214-1337-00			1						PIN, spring, 0.10 OD x 0.25 inch long
	131-0608-00			24						TERMINAL, pin, 0.365 inch long
	131-0993-00			2						LINK, terminal connector
	- - - - -			-						each link includes:
	352-0169-00			1						HOLDER, terminal connector, 2 wire <i>(black)</i>
	131-0707-00			2						CONNECTOR, terminal
-172	670-0916-00			1						CIRCUIT CARD ASSEMBLY—MODE CONTROL A2
	- - - - -			-						circuit card assembly includes:
	388-1600-00			1						CIRCUIT CARD
-173	136-0269-00			3						SOCKET, integrated circuit, 14 pin
-174	136-0237-00			3						SOCKET, integrated circuit, 8 pin
-175	131-0608-00			6						TERMINAL, pin, 0.365 inch long
-176	131-0566-00			2						LINK, terminal connecting
	131-0993-00			2						LINK, terminal connector
	- - - - -			-						each link includes:
-177	352-0169-00			1						HOLDER, terminal connector, 2 wire <i>(black)</i>
-178	131-0707-00			2						CONNECTOR, terminal
	105-0171-00			2						EJECTOR, circuit card
	- - - - -			-						mounting hardware for each: <i>(not included w/ejector)</i>
	214-1337-00			1						PIN, spring, 0.10 OD x 0.25 inch long
-179	670-0917-00			2						CIRCUIT CARD ASSEMBLY—DISPLAY SCALE A3 & A4
	- - - - -			-						each circuit card assembly includes:
	388-1601-00			1						CIRCUIT CARD
	131-0608-00			12						TERMINAL, pin, 0.365 inch long
	131-0993-00			1						LINK, terminal connector
	- - - - -			-						link includes:
	352-0169-00			1						HOLDER, terminal connector, 2 wire <i>(black)</i>
	131-0707-00			2						CONNECTOR, terminal
	105-0171-00			2						EJECTOR, circuit card
	- - - - -			-						mounting hardware for each: <i>(not included w/ejector)</i>
	214-1337-00			1						PIN, spring, 0.10 OD x 0.25 inch long
-180	670-0918-00			2						CIRCUIT CARD ASSEMBLY—POSITION REGISTER A5 & A6
	- - - - -			-						each circuit card assembly includes:
	388-1602-00			1						CIRCUIT CARD
	105-0171-00			2						EJECTOR, circuit card
	- - - - -			-						mounting hardware for each: <i>(not included w/ejector)</i>
	214-1337-00			1						PIN, spring, 0.10 OD x 0.25 inch long
-181	670-0919-00			1						CIRCUIT CARD ASSEMBLY—OFFSET REG & LOADER A7
	- - - - -			-						circuit board assembly includes:
	388-1603-00			1						CIRCUIT CARD
	105-0171-00			2						EJECTOR, circuit card
	- - - - -			-						mounting hardware for each: <i>(not included w/ejector)</i>
	214-1337-00			1						PIN, spring, 0.10 OD x 0.25 inch long

FIGURE 2 CHASSIS (cont)

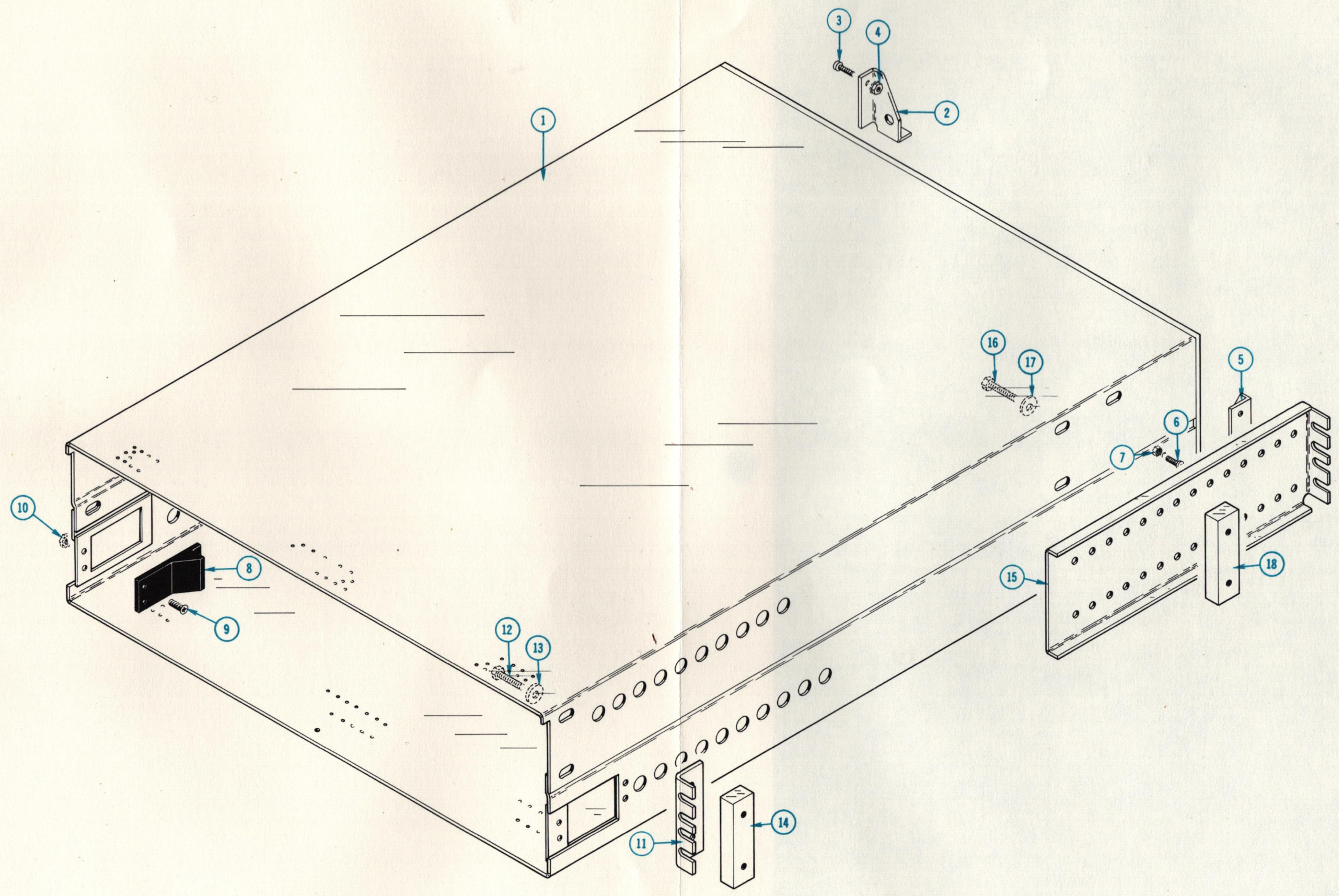
Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q					Description
				t	y	1	2	3	
-182	670-0920-00			1					CIRCUIT CARD ASSEMBLY—Z AXIS D/A CONVERTER A8
	- - - - -			-					circuit card assembly includes:
	388-1604-00			1					CIRCUIT CARD
	136-0237-00			3					SOCKET, integrated circuit, 8 pin
	136-0269-00			2					SOCKET, integrated circuit, 14 pin
	105-0171-00			2					EJECTOR, circuit card
	- - - - -			-					mounting hardware for each: <i>(not included w/ejector)</i>
	214-1337-00			1					PIN, spring, 0.10 OD x 0.25 inch long
-183	670-0921-00			1					CIRCUIT CARD ASSEMBLY—FRAME GENERATOR A9
	- - - - -			-					circuit card assembly includes:
	388-1605-00			1					CIRCUIT CARD
	136-0237-00			6					SOCKET, integrated circuit, 8 pin
	136-0269-00			16					SOCKET, integrated, circuit, 14 pin
-184	105-0171-00			2					EJECTOR, circuit card
	- - - - -			-					mounting hardware for each: <i>(not included w/ejector)</i>
-185	214-1337-00			1					PIN, spring, 0.10 OD x 0.25 inch long

STANDARD ACCESSORIES

070-1086-00	1	MANUAL, instruction <i>(not shown)</i>
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FIGURE 3 CABINET

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q						Description
				Y	1	2	3	4	5	
3-1	437-0112-00			1						CABINET ASSEMBLY
-2	407-0750-00			2						BRACKET, retaining, top right, bottom left
	- - - - -			-						mounting hardware for each: <i>(not included w/bracket)</i>
-3	211-0542-00			1						SCREW, 6-32 x 0.312 inch, THS
-4	210-0457-00			2						NUT, keps, 6-32 x 0.312 inch
	- - - - -									
-5	407-0751-00			2						BRACKET, retaining, top left, bottom right
	- - - - -			-						mounting hardware for each: <i>(not included w/bracket)</i>
-6	211-0542-00			1						SCREW, 6-32 x 0.312 inch, THS
-7	210-0457-00			2						NUT, keps, 6-32 x 0.312 inch
	- - - - -									
-8	105-0202-00			2						STOP, slide, plastic
	- - - - -			-						mounting hardware for each: <i>(not included w/stop)</i>
-9	212-0040-00			2						SCREW, 8-32 x 0.375, 100° csk, FHS
-10	210-0458-00			2						NUT, keps, 8-32 x 0.344 inch
	- - - - -									
-11	407-0844-00			2						BRACKET, rack mounting, front
	- - - - -			-						mounting hardware for each: <i>(not included w/bracket)</i>
-12	213-0090-00			2						SCREW, 10-32 x 0.50 inch, HHS
-13	210-1061-00			2						WASHER, flat, 0.203 ID x 0.625 inch OD
-14	381-0251-00			1						BAR NUT, 10-32 x 3 inches long
	- - - - -									
-15	407-0845-00			2						BRACKET, rack mounting, rear
	- - - - -			-						mounting hardware for each: <i>(not included w/bracket)</i>
-16	213-0090-00			2						SCREW, 10-32 x 0.50 inch, HSS
-17	210-1061-00			2						WASHER, flat, 0.203 ID x 0.625 inch OD
-18	381-0251-00			1						BAR NUT, 10-32 x 3 inches long



T4005/4201 GRAPHIC DISPLAY CONTROLLER

FIG. 3 CABINET